ENGINEERING CONSTRUCTION WEEKLY

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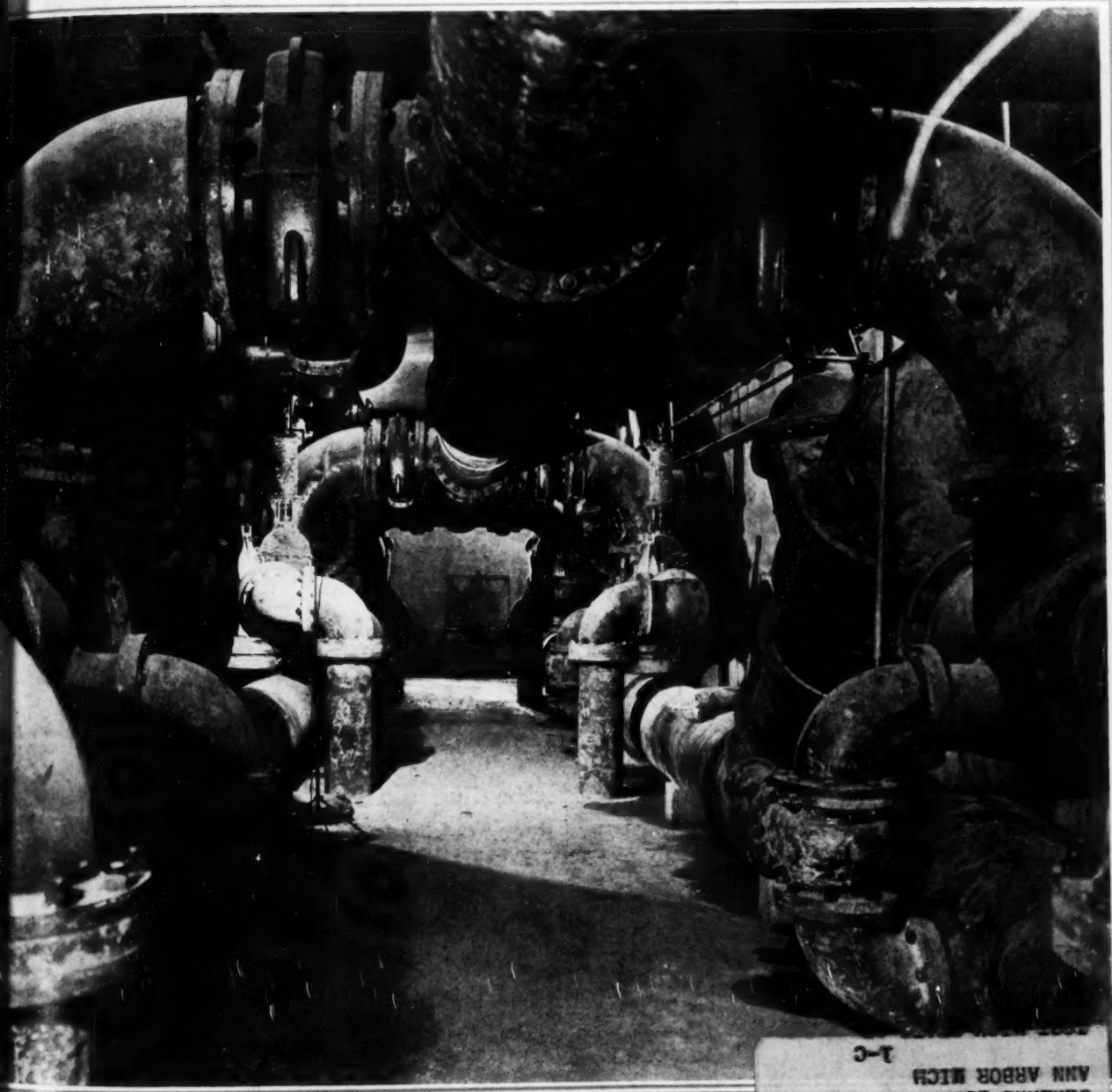

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Better Selling for Public Services

THE CONVENTION next week of the New England Water Works Association focuses attention once again on the problems and the progress of those who are responsible for the provision and maintenance of the public water supplies throughout the land. And by natural association it reminds us also of the job that must be done by those who provide and maintain the great variety of facilities and services that are so vital a part of modern community living.

From time to time this page has pointed out that this function is very "Big Business" indeed, amounting probably to something more than two billion dollars annually. And two billion dollars is big business by any man's reckoning. This concerns not at all those purely administrative functions that are the concern of civil government in its narrow sense: they comprise only those functions that involve the provision of fixed facilities. Municipal housekeeping is one of the largest engineering and industrial operations in a land of great engineering and industry enterprises.

ALL TOO SELDOM our people are brought face to face with the values thus delivered to them. Public services, unlike the products of private enterprise, do not have to be sold; at least they are not generally sold to their beneficiaries. But human nature is prone to attach higher values to those things that are consistently sold to us than to those which come as a matter of routine. Our autos and our radios we are taught by the producers to appreciate; our streets and our water supply we take for granted. With the former we are keenly conscious of the values they bring us; with the latter we are far more conscious of what they cost us.

More and more, however, our cities are learning to sell their services to their customers. This, of course, does not involve selling in the sense of soliciting orders; it means building up an understanding and appreciation of the value of those services. Recently a number of cities have devoted conscious and intelligent effort to this task, in the form of booklets, exhibits, inspection tours and other selling activities.

A recent example is from New Orleans, where a group of citizens has just issued a sales document entitled "An Outline of Twelve Months of Progress in New Orleans." It includes, in popular form, text, maps and pictures to illustrate the various municipal improvement projects that have been completed during the last twelve months.

THIS IS CITED with no intention to pass judgment on the merits of the program or its accomplishment. That is distinctly a matter of concern to the citizens of New Orleans. It is mentioned here merely to indicate another effort to visualize for the people of a great city the character and extent of the services rendered in return for their taxes and for those contributions of time and effort which are expected by a city of its citizens. What has been done here and elsewhere can be done and should be done more generally, if we are to win popular support for the many improvement projects now required for the rehabilitation and improvement of our cities.

This booklet quotes a letter from R. S. Hecht, Chairman of the Board of the Hibernia National Bank, as follows: "It has been a long time since I have had as interesting and enjoyable a morning as I have had today traveling over all parts of the city to inspect the tremendous amount of improvement work presently going on. It was indeed a revelation to me." Were it possible for the citizens of any progressive American city to make a similar tour of their own community, it probably would be a like revelation to them. But when that is not practicable, the next best thing is to see that they have, from time to time, a really interesting story of just what they are getting for their money.

Willard Chevalier

ENGINEERING NEWS-RECORD

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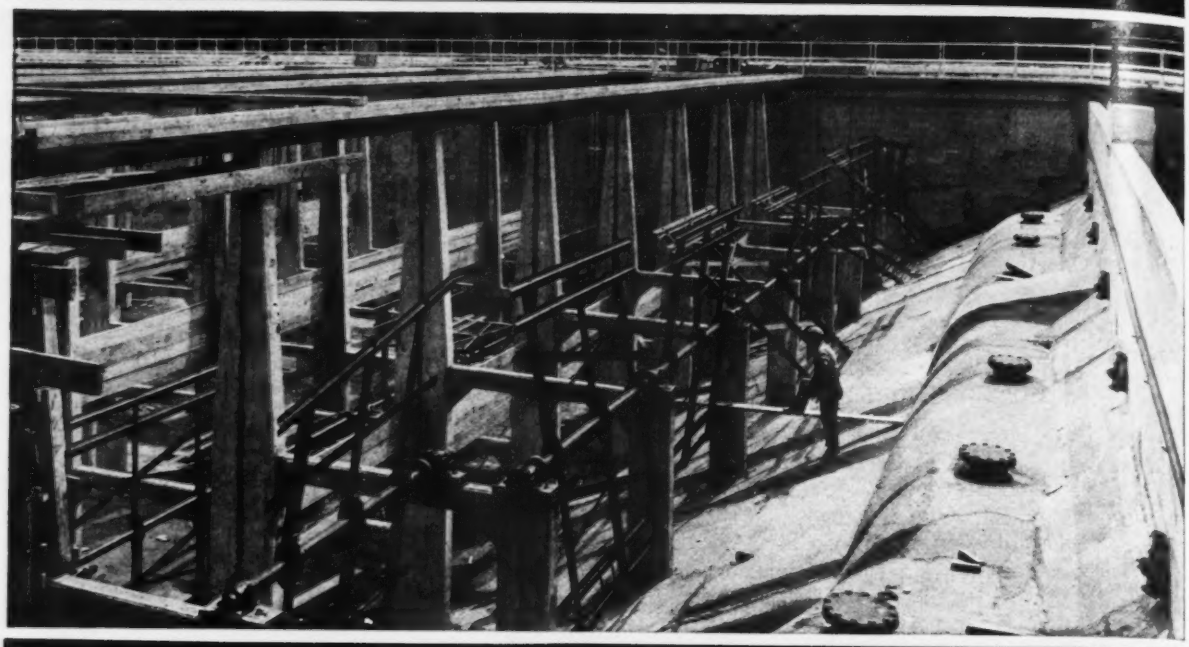

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THE Dorrco Flocculator is about the only unit in water treatment practice that is a self-liquidating investment. By effecting such substantial operating savings as shown in the tabulation above, it quickly pays for itself.

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F. E. SCHMITT, *Editor* ALBERT E. PAXTON, *Manager*

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VOL. 119 *SEPTEMBER 16, 1937* No. 12

THIS WEEK AND NEXT

CONSISTENT refinement and advance in practice have distinguished the long history of water supply engineering. In this issue a special section is devoted to some recent outstanding developments that command attention.

One of the most novel treatment plants in the country—looking like an oil refinery with its cluster of steel tanks and appurtenant piping—is described by Malcolm Pirnie.

Of more conventional design, but incorporating many new features is the purification plant at Covington, Ky., planned by J. S. Watkins. This plant goes into operation on Oct. 15.

To those who are concerned with wells, the article by E. T. Archer on elimination of clogging by means of a unique gravel-walling scheme will be of particular interest.

The economy of "floating" pipe into position becomes apparent in reading how the work was recently done when Cleveland installed two steel intake lines in Lake Erie.

Dealing misery to man and beast, the vicious "snow mosquito" creates a special problem in popular mountain recreational areas. Engineers of the Forest Service have been active in applying drainage and control measures to eliminate this pest.

Concrete walls are used to counter balance steel arch dead loads in San Francisco exposition buildings.

Driving of a large soft-ground sewer tunnel underneath the long Detroit Terminal railroad viaduct requires underpinning much of the old steel structure. The driving of 100-ft. H-beam piles and building of temporary and permanent supports for the bridge columns is told.

NEXT WEEK—Bridges on Connecticutt's Merritt Parkway are described by L. G. Sumner, state highway bridge engineer.

SPECIAL WATERWORKS SECTION

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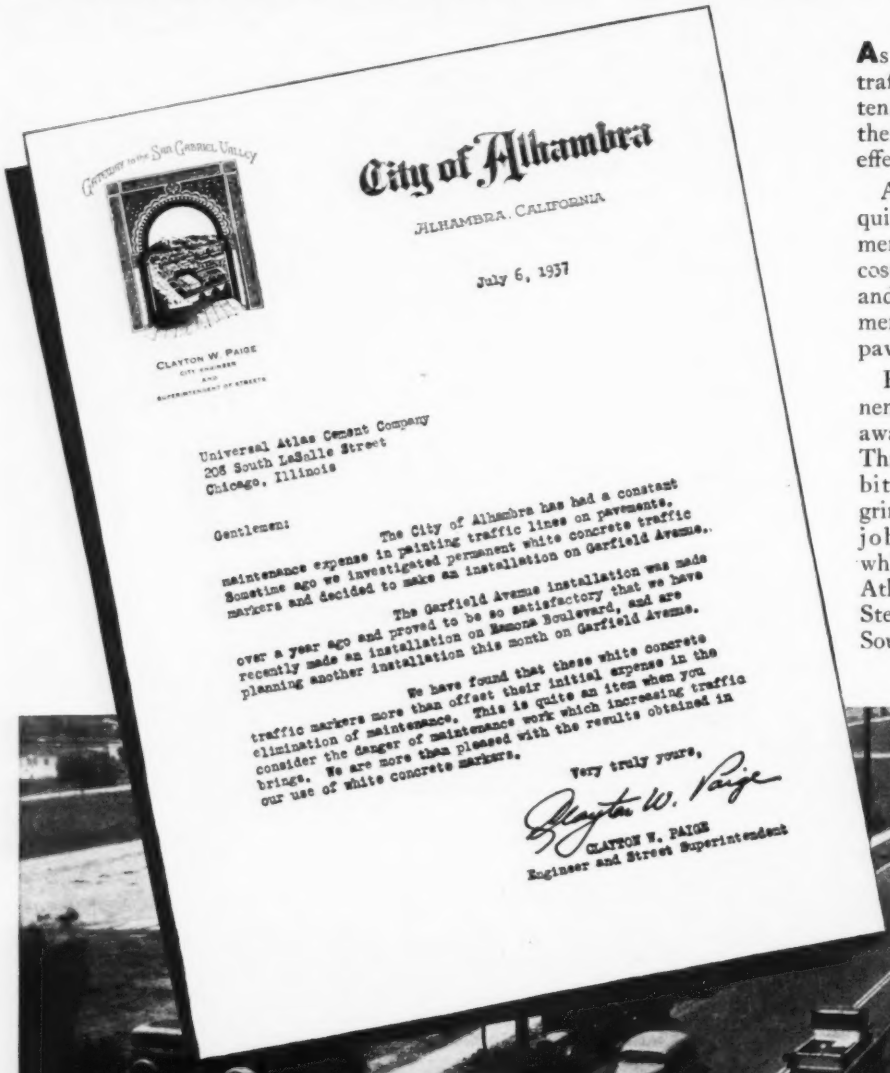
COVER PICTURE—Underground gallery in the new water filtration plant at Covington, Ky., distinguished by the symmetrical arrangement of pipes and valves.

Number of copies of this issue printed: 29,276

More concrete Evidence that

PERMANENT MARKERS PAY FOR THEMSELVES



Gateway to the San Gabriel Valley

City of Alhambra

ALHAMBRA, CALIFORNIA

July 6, 1937

CLAYTON W. PAIGE
CITY ENGINEER
AND
SUPERINTENDENT OF STREETS

Universal Atlas Cement Company
208 South LaSalle Street
Chicago, Illinois

Gentlemen:

The City of Alhambra has had a constant maintenance expense in painting traffic lines on pavements. Sometime ago we investigated permanent white concrete traffic markers and decided to make an installation on Garfield Avenue.

The Garfield Avenue installation was made over a year ago and proved to be so satisfactory that we have recently made an installation on Ramona Boulevard, and are planning another installation this month on Garfield Avenue.

We have found that these white concrete traffic markers more than offset their initial expense in the elimination of maintenance. This is quite an item when you consider the danger of maintenance work which increasing traffic brings. We are more than pleased with the results obtained in our use of white concrete markers.

Very truly yours,

Clayton W. Paige

CLAYTON W. PAIGE
Engineer and Street Superintendent

As this letter states, white concrete traffic markers put an end to maintenance expense—actually pay for themselves in the savings they effect.

Atlas White markers never require painting, or repair, or replacement. Their first cost is the last cost. They are made of concrete and so are built right into the pavement. They last the life of the pavement.

Because they have the permanence of concrete, they don't fade away, or wash away, or wear away. Through years of blistering sun, bitter cold, flooding rains, and grinding traffic, they stay on the job constantly—permanently white, and easy to see. Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), 208 South La Salle Street, Chicago.

M-14

Atlas White traffic markers on Garfield Avenue, Alhambra, Cal. Installed by city forces under supervision of Clayton W. Paige, Engineer and Street Superintendent.

USS

ATLAS WHITE PORTLAND CEMENT

FOR TRAFFIC MARKERS

THE WEEK'S EVENTS

Argue Navigability Of Yadkin

FPC reopens hearing on whether North Carolina project needs federal license

Further testimony as to whether or not the proposed hydroelectric development of the Carolina Aluminum Co. on the Yadkin River near Tuckertown, N. C., requires a license under the provisions of the Federal Water Power Act was received Sept. 13 at a re-opened hearing before the Federal Power Commission.

In the belief that the river is non-navigable, the company as required by law on June 7, 1937 filed a declaration of intention to construct the plant. The commission, in order to collect evidence on the point, held a public hearing July 23 and directed the filing of briefs by Sept. 15. Subsequent reports quoting North Carolina officials to the effect that the river is obviously not navigable and that the Federal inquiry was unduly delaying the start of construction led the commission, on its own motion, to re-open the hearing to give the state an opportunity to present evidence bearing on the issue.

The proposed development at Tuckertown consists of a gravity-type concrete dam 1,320 ft. long and 93 ft. high to store 23,000 acre-ft. of useable storage and a 54,000 hp. powerhouse operating at a normal head of 55 ft. Its purpose is stated to be the generation of electric power for public service and for industrial use by the aluminum company. It is located immediately below the High Rock development of the same company and above dams at Narrows, Yadkin Falls, Lake Tillery and Blewett Falls, the latter two being properties of the Carolina Power and Light Company. None of these is licensed by the federal government and none is equipped with navigation locks.

Representatives of North Carolina maintained that the Yadkin at Tuckertown is not now, and has never been, navigable to interstate commerce; that the lower Pee Dee River (the continuation of the Yadkin in South Carolina) cannot possibly suffer any adverse effect from the proposed development; that the matter therefore is under state and not federal jurisdiction. It was brought out that the proposed storage at Tuckertown would add only 4.3 per cent to the capacity of the five existing dams, and that any effect from water released there would be completely damped out by the four dams intervening between the project and the head of navigation.

Cross-examination by commission attornies developed the fact that the state exercises no control over the operation of its hydroelectric plants nor over their adequacy of design or construction costs. There is no provision

(continued on page 455)

• • •

Supreme Court Asked to Tax Federal Contractors

Attorney-General Cummings asked the Supreme Court Sept. 7 to re-examine its previous decisions under which contractors performing work for the federal government have been held exempt from state taxation.

The request was made in a "friend of the court" brief in connection with three cases which the court heard last term but which it has ordered reargued so that the federal government may present its views. The cases involve imposition of taxes upon the Dravo Contracting Co. of Pittsburgh, engaged in lock and dam construction on the Ohio River, and cases involving a state occupation tax imposed by the state of Washington, the constitutionality of which has been attacked by a group of contractors on the Grand Coulee Dam.

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State Action Proposed On Flood Control

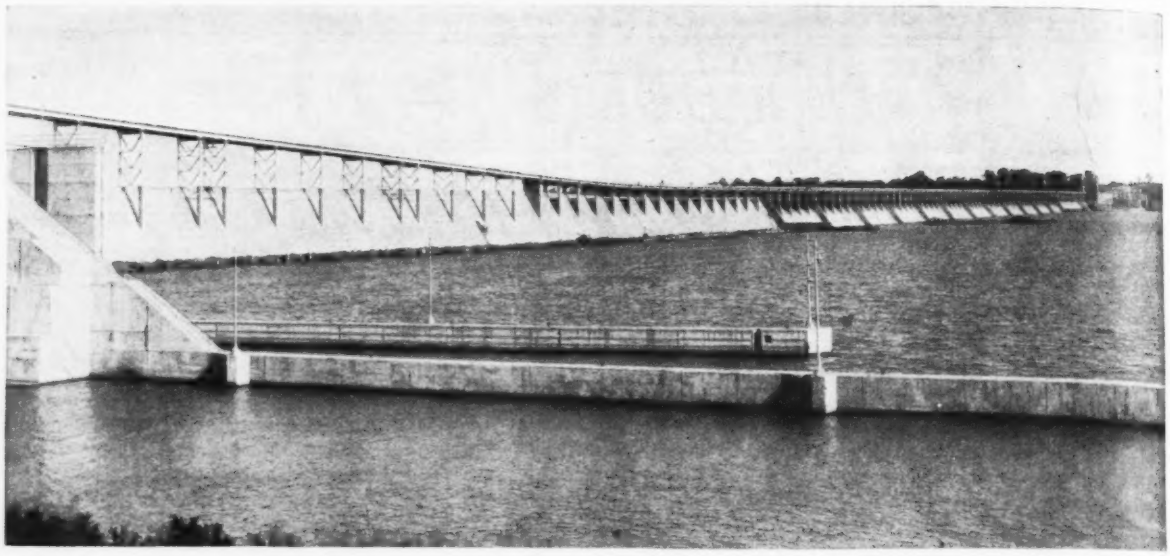
New England states consider means for Connecticut and Merrimack control without federal aid

Attorney General Daly of Connecticut has suggested a plan whereby Connecticut, Massachusetts, New Hampshire and Vermont may proceed with a flood control compact by interstate action without federal help. The plan would call for the formation of an interstate corporation set up by the four states interested in flood control. Under the plan a corporation would be charted in each of the four states but with a single group of officers.

The chief obstacle to such a plan is the constitutional provision that "no state shall, without the consent of Congress, enter into any agreement or compact with another state." On this point Attorney Daly raises the question whether consent of Congress may not be inferred from the flood control act of 1936, on the basis of which the original interstate compact was formulated to which approval was refused by the last Congress.

Opposition has been expressed in all the New England states to a compact that would give the federal government control of power development. Governor Murphy of New Hampshire recently stated, "I shall never give my approval to any arrangement which would involve the surrender to the federal government of New Hampshire's natural resources."

The four New England states recently agreed to an interstate compact under which the states would provide land and rights-of-way for dams to be constructed by the federal government under the terms of the omnibus flood control act of 1936. This contract contained a provision reserving to the states all rights to power generated in connection with any flood control project. The Federal Power Commission strongly objected to this provision, and on the basis of its objection Congress refused its approval to the contract. Congress did, however, pass a bill approving in advance a contract drawn up without any such power reservation.



TENNESEE VALLEY AUTHORITY'S WHEELER DAM IS FORMALLY DEDICATED

WHEELER DAM, $37,000,000 TVA project, second of the TVA dams to be completed and placed in service since the formation of the authority, was formally dedicated Sept. 10 on the 101st anniversary of the birth of General Joseph Wheeler, after whom the dam is named. The dam was completed early this year, but formal dedication was delayed until the anniversary.

The dam, about 15 miles upstream from Wilson Dam at Muscle Shoals, impounds a reservoir which carries navigation in the Tennessee 74 miles upstream to Guntersville dam, now under construction. An initial hydro-electric installation has 45,000 hp.

President Roosevelt, in a telegram sent to the TVA on the occasion of the dedication, stated: "The entire nation has a vital interest in the dedication today of this important link in one of the nation's great hydro-highways. . . . Through unified control, the Tennessee River is stepped up for navigation and, in reverse order, stepped down for flood control. . . . At the same time incidental generation of power by these 'steps' provides a means of reimbursing the government in large measure for the moneys expended for the development and control of our interior waterways . . ."

Wilson Dam, constructed during the war, was deeded to the TVA by the government. Norris Dam on the Clinch River was completed last year, and Pickwick and Guntersville Dams are now under construction.

Duke Power Company Case Reaches High Court

The U. S. Supreme Court Sept. 10 was asked for the second time by the Duke Power Company to review its plea for an injunction against a PWA allotment to Greenwood County, S. C., for the construction of the Buzzards Roost hydroelectric power project. With over fifty similar cases pending in various jurisdictions, the Supreme Court has already consented to review several brought by the Alabama Power Company and the Iowa City Light and Power Company which will be argued this fall.

Counsel for the Duke Power Co., asserting that in competition with the lower rates already contracted for by the Buzzard Roost plant, the company would lose $250,000 annually, contends that the loan and grant allotted under the NIRA was unconstitutional because the law exceeded congressional powers, because it invaded the rights of the states, and because it provided for undue delegation of power to the president and deprived the power company of property without due process.

The PWA loan and grant of $2,852,000 to Greenwood County was made July 18, 1934 and was taken to the courts shortly thereafter. After being carried through to the U. S. Supreme Court, the case was remanded for retrial on technical grounds and has now been brought, for the second time, through the U. S. District Court and the U. S. Circuit Court of Appeals. The latter recently upheld the constitutionality of the PWA allotment and refused to grant the injunction.

• • •

Record Payroll Attained At Grand Coulee

The number of men working at Grand Coulee in August reached a peak of 6,800, of whom about 600 were on the Bureau of Reclamation payroll.

For the month of August the total payroll was $1,051,856, of which $962,433 constituted the contractor's payroll and $89,423 was paid by the Bureau of Reclamation. Man-hours for the month, exclusive of office force and administration, totaled 1,240,630, the government man-hours being 128,976.

To Study Dust Hazard At Safety Congress

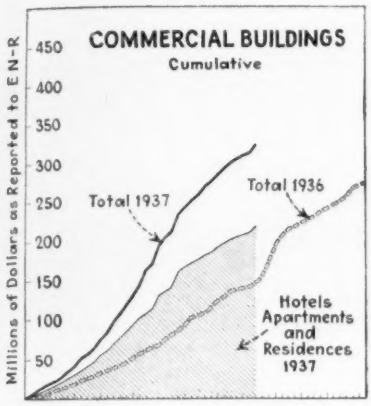
A one-day session of the Engineering section of the 26th National Safety Congress and Exposition to be held Oct. 11-15 at Kansas City, Mo., will be devoted to the subject of dust hazards and control. The chairman of this section, which will meet Oct. 13, will be A. F. Regula, executive secretary and vice-president for engineering of the Industrial Relations Counselors, Inc., New York City.

Dr. R. R. Sayers, senior surgeon and chief of the division of industrial hygiene of the National Institute of Health, U. S. Treasury Department, will speak on the subject "What Industrial Dusts Are Hazardous? Why?" In his paper he will note the hazards associated with various dusts ranging from the most toxic to the least harmful, with emphasis on control.

"The Engineer's Part in Eliminating Dust Hazards" will be discussed by Arthur F. Johnson, assistant to the manager of the engineering department, American Mutual Liability Insurance Co. of Boston.

THE CURRENT TREND

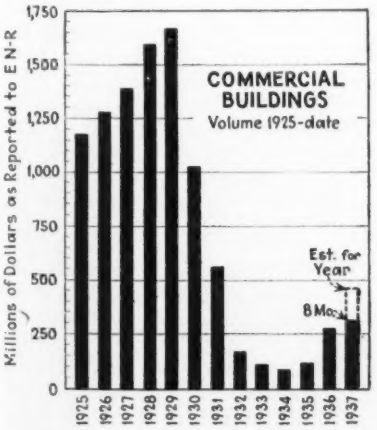
This week's news of contract volume and construction cost factors



Commercial Building Up But More to Go

Commercial building construction volume during the first 36 weeks of this year totalled $325,000,000, 18 per cent more than the entire year of 1936 and 124 per cent more than the corresponding, but 37-week, period of last year.

These percentages show a spectacular rate of improvement until comparisons are made with post-depression building volume. At the current rate for 1937 the year's volume will top $460,000,000 for commercial building. This compares with the all time high record of $1,670,000,000, and a 12-year (1925-36) average of $787,000,000. Compared with the low year, $81,000,000, this year's rate is a 475 per cent gain. It still has a long way to go.

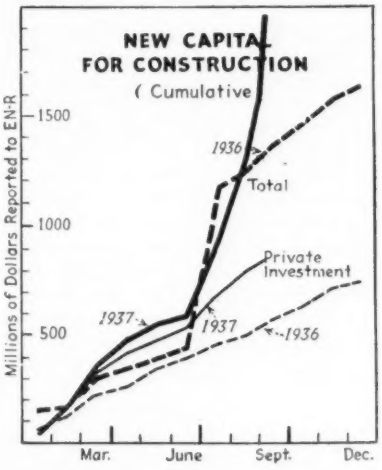


Seven years of the past twelve have exceeded this year's activity, six have exceeded $1,000,000,000.

Of this year's volume, 67½ per cent is in large scale residential, apartment and hotel construction.

Construction Financing Extends Gain

The new productive capital curve almost climbed off the top of the chart this month with the addition of more 1938 federal appropriations and one fourth of the WPA funds earmarked for construction. New capital for construction is now 48 per cent higher than for the corresponding period last year. Private investment capital for construction is running 51 per cent higher than last year.



Construction Briefs

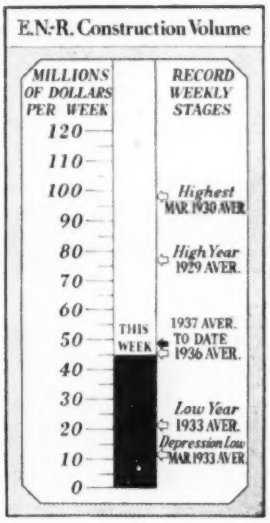
PORTLAND CEMENT ASSOCIATION pavement statistics for August indicate a 2 per cent drop behind last year for the month and an 11 per cent gain for the 8 months over the corresponding 1936 period. Roads and alleys are ahead, streets are lagging. The totals as reported are:

	Square Yards Awarded August, '37	8 mo., '37	8 mo., '36
Roads ..	4,216,087	28,144,651	24,378,730
Streets .	1,466,918	9,108,108	9,421,674
Alleys ..	100,361	379,366	254,176
Total .	5,783,366	37,632,125	34,054,580

THE AUGUST CONSTRUCTION Cost Index (average for 30 cities) reported by American Appraisal Co. remains at 185, unchanged from July.

BUILDING PERMITS reported by Dun & Bradstreet resumed their rise in August above the 1936 rate. Volume for 215 cities, $87,545,062.

SURVEYING THE NEW HOMES built in 1936, Investors Syndicate, Minneapolis, concludes that for the first time in six years the new homes built in 310 American cities exceeded the requirements of estimated population increase in those cities. For example, housing provided for 491,608 people, while the estimated population gain was 483,757. The survey also revealed that the per capita cost of new homes was $1,019, or 10.3 per cent less than in 1930, which was considered a normal building year; the low point reached was $874 in 1934. Costs in 1936 were 9½ per cent over the 1935 level.



THIS WEEK'S FIGURES

(Thousands of Dollars)

CONTRACTS

	Week Ending Sept. 17 1936	Sept. 9 1937	Sept. 16 1937
Federal	$5,617	$2,982	$5,528
State & Municipal	20,252	18,140	21,038
Total public ..	$25,869	$21,122	$26,566
Total private.	30,513	15,746	20,781
TOTALS	$56,382	$36,868	$47,347
Cumulative 1937 (37 weeks).....			$1,801,237
1936 (38 weeks).....			$1,669,618

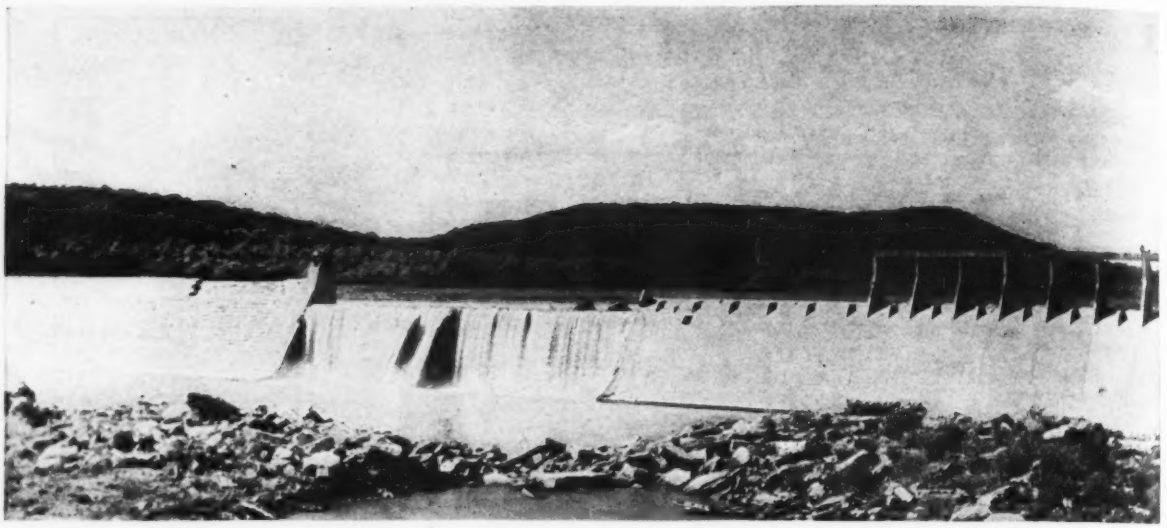
Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1936 38 Wks.	1937 37 Wks.
NON-FEDERAL.	$669,687	$1,214,298
State & mun. bonds	362,467	387,214
Corporate securities.	291,476	440,326
PWA loans, grants..	80,746	156,819
RFC loans	24,998	29,939
Fed. aid for highways		$746,223
FEDERAL	$691,237	$746,223
TOTAL CAPITAL....	$1,360,924	$1,960,521

ENR VALUES

	1913	1926
Index Base		
Construction Cost (Sept.)...	243.95	117.27
Construction Volume (Aug.)	150.	66.



PLANS TO REHABILITATE AUSTIN DAM MOVE FORWARD

PRELIMINARY arrangements for the rehabilitation of Austin Dam, located on the Colorado River of Texas at Austin, have been completed by the city and the Colorado River Authority. Under the terms of the proposed agreement, the dam will be rehabilitated by the authority at a cost of about $1,800,000 financed by a PWA loan and grant. The dam will be leased to the authority for a 30-year period, after which it will be repurchased by the city at the actual cost of improvements made by the authority, less depreciation. During the life of the lease, the authority will furnish $20,000 worth of free power to the city as rental for the dam.

The original Austin Dam, built 1890-93 of local limestone rubble faced with native red granite, was destroyed by flood April 7, 1900. The present structure was constructed in 1911 but was never accepted by the city. The property later became involved in litigation, was placed in receivership, and finally sold at a foreclosure sale. In 1934 the city obtained title to the structure under a federal court decree.

Preliminary plans indicate that the dam will be reconstructed to a height of 63 ft. and that a new power house will be built on the west side of the river. An initial installation of 6,250 kw. generating equipment will be made as well as provision for an additional 6,250 kw. when Marshall Ford dam, twelve miles upstream, is completed and adequate water is available for that much power.

Damage to the present structure by the floods in 1935 and 1936 can be seen in the picture.

Penn. Finance Building Gets PWA Allotment

Construction of the new Finance Building of the Commonwealth of Pennsylvania is provided for by an allotment of $7,095,000 of PWA funds. The building, largest to be erected by PWA in Pennsylvania, will be constructed as a part of the works program of the General State Authority and must be put under construction before November 8, 1937.

Of the total allotted, $1,091,000 is a cash grant. Of the remainder 133 1/3 per cent of the amount spent on wages for relief labor will also be credited as a grant.

The Finance Building is the largest of the Pennsylvania General State Authority projects. It will be a seven-story structure of steel frame and reinforced concrete construction, faced with granite. It was designed by Gehron & Ross of New York.

More projects

Thirty-four additional loans and grants to the Pennsylvania general state authority were announced by PWA Sept. 13. The projects call for allotments totaling $15,348,000, with outright cash grants of $2,516,000 and gross loans, including a grant of 133-1/3 per cent of the amount spent for relief labor wages, of $13,382,000.

Most of these allotments are for state armory building, there being fourteen on the list. Eleven of the projects are for hospital improvements and eight are for schools. Among the larger individual allotments were one of $2,847,000 for a hospital at Pittsburgh and allotments of $1,731,000 for additions to the Warren State Hospital, and $1,418,000 for additions to the Pennhurst State School.

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Largest Muskingum Dam To Be Dedicated

The Mohawk Dam in the Walhonding River valley near Warsaw, Ohio, largest dam in the Muskingum Watershed Conservancy District, will be dedicated Sept. 23. The dam is complete with the exception of a few minor details.

The Mohawk Dam is an earth-fill structure, 111 ft. high and 2,330 ft. long. It cost $6,235,000.

Flourine Removal Method Found by Chemist

Development of a method of removing flourine from drinking water has been announced by Prof. H. G. Smith of the University of Arizona. His method is based on filtering water through granulated animal bones. Dr. Smith finds that this substance has a particular affinity for flourine.

Prof. Smith estimates the cost of his method as about one-half cent per gallon. He is able to clean and renew his filters by washing with sodium hydroxide and by neutralizing the alkali with a solution of hydrochloric acid.

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New Clyde Bridge Contract Awarded

The corporation of the city of Glasgow, Scotland, has awarded the contract for the erection of the Finniston Bridge over the river Clyde to the Cleveland Bridge & Engineering Co., of Darlington, England, for $3,114,000.

The bridge will cross the river about a mile west of the center of the city. Its cost will be about $6,250,000.

Bonneville Head Not Yet Chosen

Special correspondence

Selection of an administrator for the Bonneville project on the Columbia River is proving to be a ticklish job, to judge from the administration's delay in filling the office created just before the adjournment of Congress. With the dam approaching completion and the possibility that saleable power can be produced by the end of the year, there is every incentive for prompt action in setting up an organization to negotiate power sales contracts. Yet, although the law was approved Aug. 20, no indication has been given that an appointment is imminent.

Whoever is appointed will find the job no government sinecure. He will face the difficult task of securing markets for an initial installation of 86,000 kw., to be increased as rapidly as possible to 430,000 kw., in a section where present rates are lower, and average usage higher, than in any other part of the country. Hanging over him will be the present competition of both private and municipal generating plants and the not-far-removed complication of a huge additional block of low-rate power from the Grand Coulee development 200 miles to the eastward. Finally, he will land in the middle of a bitter sectional battle between those who favor a "postage-stamp" or uniform rate for all purchasers within transmission distance and those who believe that nearby communities should not be called upon to carry part of the transmission costs to areas more distant from the plant.

Ross is likely choice

To handle the job successfully the appointee must possess a thorough knowledge of the technology and economics of large-scale transmission and marketing problems and he must, for obvious reasons, be unmistakably identified with the public ownership movement. The number of such men is limited. Outstanding among them is J. D. Ross, superintendent of the Seattle municipal lighting department and a member of the Securities and Exchange Commission. So obvious are his qualifications that Washington speculation on the delay in his appointment is more concerned with the hidden reasons for procrastination than with the possibility of a rival candidate.

The rumour, on which neither an affirmation nor a denial can be obtained from any reliable source, is that the job has been offered to Mr. Ross on the condition that he sever all connections with the Seattle system. This, it is said, he will not do; therefore the deadlock. It is pointed that he has been connected with the Seattle project since its inception, is largely responsible for its steady growth to outstanding proportions, and is loath to relinquish command at a time when the municipal system seems on the verge of taking over the competing private system owned by the Puget Sound Power and Light Company. Since his appointment to SEC he has successfully filled both jobs, despite the fact that over 3,000 miles intervene between Washington and Seattle; it would, therefore, be comparatively simple for him to function as both Bonneville administrator and superintendent at Seattle.

On the other hand, it is said that the Bonneville job is entirely too important to be filled by a part-time man, particularly one who is intimately connected with a municipal plant which, although outside of the immediate service area surrounding Bonneville, is still close enough to be affected by a rate differential. It is further claimed that although Mr. Ross is undeniably a public power advocate, he favors municipal rather than federal development, and opposed the construction of Bonneville by the federal government when this was first proposed.

Whether the outcome will be a victory for the administration or for Mr. Ross, or whether the final solution will be the substitution of some other person, is still undecided—but it is a question that will have to be answered soon.

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Federal Building Projects Are Approved

Approval of 319 public building projects to be paid for out of the $70,000,000 emergency construction fund authorized under the Third Deficiency Act of August, 1937, has been announced by the Treasury and Post Office Departments. Most of the buildings to be constructed are post offices. All of the funds authorized under the deficiency act have been allocated.

The present $70,000,000 authorization is a continuation of a program which was financed by appropriations of $65,000,000 in 1934, $60,000,000 in 1935, and $60,000,000 in 1936. The program contemplated by the present authorization will extend over a period of three years. The Secretary of the Treasury is authorized to enter into contracts for any or all of the projects erected under this program, but the maximum obligations for the current fiscal year are limited to $30,000,000.

Work on the projects selected under the new program will go forward immediately.

Grade Elimination Pushed in N. Y.

Burying of Long Island Railroad tracks in Brooklyn urged at cost of $30,000,000

A favorable report has been made to the New York City Board of Estimate on a project to eliminate grade crossings for a 20 mile stretch along Atlantic Ave., Brooklyn, from East New York to Jamaica by changing the grade of the Long Island Railroad. The recommended plan would provide for depression of the railroad tracks and construction above them of a 6-lane express highway as well as general landscaping and improvement. An alternate, but not recommended, plan would provide for elevation of the track above street level.

The estimated cost of the recommended project is $13,000,000, of which about $9,000,000 will be for grade crossing elimination and the rest for city improvement work. Of the $9,000,000, under state law the railroad would pay 50 per cent, the state 49 per cent, and the city 1 per cent. There is some question, however, whether the railroad can be required to pay more than an amount equal to half the cost of the cheaper elevation project.

The project was originally proposed by the city transit commission and was submitted to the board of estimate in April, 1932. A special committee for its study was appointed, but no action has been taken until the present time.

The matter is scheduled to be taken up at the first meeting of the Board of Estimate September 24.

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Big Increase Found In Housing

There were 118,597 dwelling units provided in the urban area of the United States during the first half of 1937, an increase of more than 33,000 units or 39 per cent over the first half of 1936, according to estimates of the Bureau of Labor Statistics. These estimates are based on reports received by the bureau from more than 1,500 cities with a population of about 59,000,000 and comprising 85 per cent of the entire urban population.

The bureau's figures show increases in number of dwelling units provided in cities of all sizes, but the rate of increase was somewhat greater in cities having a population of less than 25,000. All geographic divisions shared in the increase. Most pronounced gain was registered in the Pacific Coast states.

LABOR NOTES

AN ELECTION held Sept. 10 at the Ambridge, Pa. plant of the National Electric Products Corp. over protests of an A.F. of L. group and as that body began court action intended to void its results, resulted in an apparent victory for the American Federation of Labor union. The election was called in an attempt to settle one of the most complicated cases which has arisen under the Wagner Act and determine whether the 1,600 employees of the company should be represented by the International Brotherhood of Electrical Workers, A.F. of L., or by the United Electrical and Radio Workers, C.I.O. (*ENR*, Sept. 9, 1937, p. 412). In the election the A.F. of L. received 780 votes and the C.I.O. group 675. These results, however, were subject to change, inasmuch as they did not include 150 votes which have been challenged and on which a decision has not yet been reached by the NLRB. The case arose when the C.I.O. complained before the labor relations board of a closed shop agreement between the company and the A.F. of L. group. Since the closed shop contract had previously been upheld by the Pittsburgh district court, the company and the A.F. of L. have claimed that the NRLB did not have jurisdiction.

At the same time the American Federation of Labor lifted the boycott electricians had been enforcing against products of the company during the dispute.

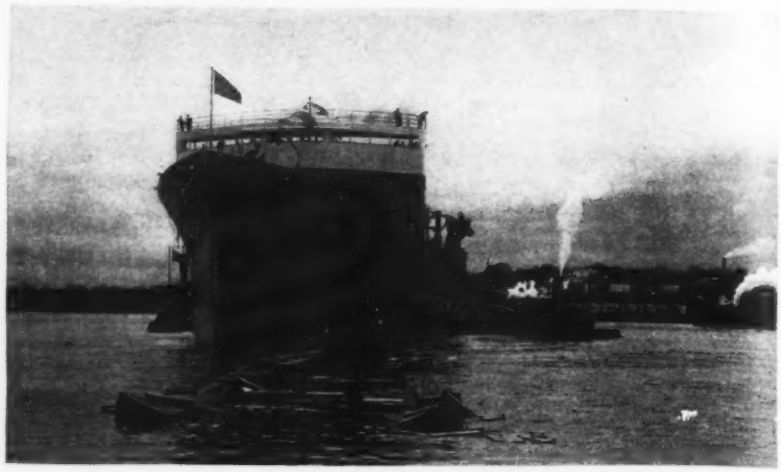
But another vote, at the other end of the country, went favorably to the C.I.O. In Nevada, workers on the $1,000,000 Boca dam storage project, in a vote held Sept. 2, confirmed a contract already signed between the George W. Condon Construction Co., the contractors, and the C.I.O. Votes were cast by 67 employees of the company who were employed on the project prior to a labor trouble shutdown in mid-July (*ENR*, July 29, 1937, p. 168). The lockout ended Aug. 11, when the contractor and the A.F. of L. and C.I.O. labor organizations agreed to resume work on a truce basis until a secret ballot could be taken among workers employed at the time of the shutdown. Of the 67 votes cast, 46 favored the C.I.O. agreement and 21 were for the A.F. of L. President L. M. Christensen, of the conservation district, was in charge of the polls, and two representatives of each of the labor bodies sat on the election board. About bodies sat on the election board.

Meanwhile, in Virginia, the dispute between the two labor groups took a hitherto unprecedented turn when the C.I.O. took over bodily the West Virginia Federation of Labor, issuing it a charter as the West Virginia Industrial Union Council. The state federation was expelled from the A.F. of L. when it refused to obey orders to expel C.I.O. local unions. The C.I.O. has previously chartered industrial union councils in other states, but this is the first case in which it has taken over an entire state federation.

And in California, a C.I.O. construction union won a partial victory as the result of a brief strike called against Fredericksen & Westbrook, contractors on a highway construction project between Soda Springs and Donner. The compromise agreement provides for a 15 per cent wage increase and recognition of the union as bargaining agent for its members, but did not provide a closed shop.

The closed shop took another blow on the West Coast Sept. 12 when the Building Contractors Association of Southern California announced that they would employ building workers regardless of union affiliation. At the same time the association announced recognition of American Federation of Labor Unions as sole bargaining agents for their members and asked the unions to recognize the association as sole bargaining agent for general building contractors in Los Angeles.

The statement of policy included announcement of a new minimum wage scale which is intended to be revised every six months in accordance with variation of the government index of the cost of living. Minimums established are $8 per day for finish car-



WORLD'S BIGGEST DREDGE

THE WAR DEPARTMENT'S new hopper dredge, the Goethals, which was launched late last month, with its overall length of 476 ft., loaded draft of 25 ft. and a hopper capacity of 5,000 cu.yd., is the world's largest dredge. It will work to a maximum cutting depth of 50 ft.

Four boilers operating at 425 lb. pressure supply steam to the turbo-electric generators. Two electric propelling motors are each rated at 2,250 hp., and two 32-in. dredging pumps are each driven by a 1,300 hp. motor.

The dredge is of the two-compartment type, so that when fully loaded and with two compartments flooded the vessel will still float. All transverse bulkheads are solid from keel to upper deck except between boiler and machinery spaces, and the dredge is so designed that should all hopper doors on one side be opened and one-half the total load dumped, the dredge would still be within its range of stability.

Two 90-ft. dragarms are provided, one on each side of the dredge, with swivel elbows located slightly above light draft line so that they may be shipped and unshipped without placing the dredge in drydock. The hopper space is divided into four compartments and each compartment is provided with four hopper doors for dumping the load. The doors operate in groups of four, each group being operated by a motor through line shaft and worm gears.

The rudder area is double that of the ordinary ship, and to provide more efficient steering at dredging speed, about two miles per hour, two rudders are used, one directly aft of each propeller.

The dredge was designed and plans and specifications were prepared in the marine design section of the office of the Chief of Engineers.

penters, cement finishers, electrical workers, bricklayers, painters, roughers, waterproofers, and sheet metal workers; $6.40 for rough carpenters; $6 for tile setter's helpers and bricklayers' helpers; $5 for common labor; $10 for plumbers; $9 for tile setters; and $1.25 an hour for plasters and lathers with $1 an hour for plasterer's tenders.

A painters strike in New York City which has halted nearly all painting work there and has tied up work involving New York contractors in numerous eastern cities (*ENR*, Sept. 2, 1937, p. 370) seemed near its end Sept. 13 as half the strikers in Brooklyn went back to work under contracts providing for wage increases and as agreements were submitted to be voted on by the union membership in the other boroughs. The Brooklyn settlement, affecting 1,200 members, about half of those on strike, provides for a 7-hr. day at a daily wage of $11.20, as compared with a previous $9 wage for the same number of hours. Shop and job stewards are provided for, and the closed shop is to continue in effect with 50 per cent of all men to be hired directly through the union.

An economy move on the part of the Arizona highway department, reducing the work week of all department employees from 44 hours to 40 hours, was abandoned Sept. 8 on the advice of Governor Marland. The department was faced with a situation in which recent advances in the wage scale, adopted Aug. 1, made it impossible to stay within the budget for the year. As an alternative to the 10 per cent wage cut, the department is dropping projects from its construction and maintenance program. A reduction of $1,373,000 has been made in the state's $4,000,000 force account program; 619 employees have been dismissed on account of the retrenchment and dismissal of about 400 more is expected.

The Columbus Building Supply Co. will employ union drivers and warehouse employees under the terms of an agreement signed with the Columbus Building Trades Council. This is the first time that the Columbus Council has had an agreement with a building supply company.

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Appraisers Set Meeting

Progress has been made in the planning of the National Appraisal Forum which the Joint Committee on Appraisal and Market Analysis is to hold Nov. 19-20. It has been definitely decided to hold the forum in the city of Washington, D. C.

Argue Navigability of Yadkin

(*Continued from page 449*)

for recapture of the power plants in the future. It was admitted that, if the existing dams had been provided with locks, boats could navigate through the chain of reservoirs—although this would require a total lift of 463 ft. and the chain would be broken by existing shoals at two points. It was also brought out that the aluminum company power system is interconnected with transmission lines of the Carolina Power and Light Co. and of the Duke Power Co., and that power from the proposed project could thus be fed into either or both systems if desired.

Speakers for the state of South Carolina stated that the right of that state to receive water for navigation has been adversely affected by the chain of existing power dams, which are controlled by neither the federal government nor the state of North Carolina. He implied that the commission should have assumed jurisdiction over the river long ago in order to prevent this damage.

A. L. Bronson, civilian assistant to the district engineer of the War Department at Charleston, testified as to the navigability of the lower stream. The present project calls for a 9-ft. channel to Smithville, S. C., 52 miles above the mouth of the river, and a 3½-ft. channel on up to Cheraw, S. C. at Mile 101. Commercial navigation, however, is rare above Jeffery's Creek, Mile 89. Stage fluctuations recorded at Cheraw are unnatural, he testified, and are probably caused by the operation of the power plants upstream, although no definite evidence was presented to this effect. The fluctuations have at times reduced the stage to 1½ ft. below what would have obtained under conditions of natural flow, and the effect of these fluctuations has been observed 66 miles further downstream. Cross-questioning brought out that the Chief of Engineers has recommended the abandonment of the upper part of the Pee Dee project and that the annual value of present commerce on the river is very low.

The commission pointed out that the project can be carried on regardless of which way the decision goes, the only difference being whether the project will be licensed or not licensed. Counsel for the company countered with the statement that the matter is not quite so simple; that if the commission insists upon a license this will render the project subject to annual charges, ultimate recapture by the government, and other restrictions, and that it may prove advisable for the company to seek judicial review of such a decision.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

INTENSIVE study of properties and suitability of housing materials with special stress on cheapness and use in low-cost construction has been started by the Bureau of Standards, which is using a $19,000 appropriation voted for the inquiry in the recent session of Congress. Detailed programs outlined include studies on bearing walls, partitions, floors, roofs, heating and ventilating equipment and plumbing suitable for low cost construction.

The program is being mapped out under the advice of representatives of the various housing agencies of the Government, and the subcommittee on design and construction of the Central Housing Committee has named a special group to cooperate with the bureau in the work. This group is headed by Harold D. Hynds, chairman, and includes C. W. Chamberlain of the Treasury Department Procurement Division, Pierre Blouke of HOLC Walter Jung, FHA, Charles Mayette, PWA, Vincent B. Phelan, Bureau of Standards, Colin O. Skinner, RA, George W. Trayer, Forest Service, and Capt. Elsmere J. Walter, Quartermaster Department, U. S. Army.

Specifications for the Vallecito dam on Pine River in Colorado have been completed by the Bureau of Reclamation. The project will be advertised in the near future.

Water will be turned into the first twenty miles of the all American canal next August, according to present estimates. Completion of the canal to the Imperial Valley will not be until the summer of 1939.

Delay in securing funds for the Gila Canal probably will not retard the project as a whole. A contract already has been awarded (to the George Pollock Co. of Sacramento) for processing the concrete aggregates for the syphon and other structures along the Canal.

All of the 65 units soon to be opened on the Klamath reclamation project will go to ex-service men. More than 1,000 persons have indicated a desire to take up one of these units. Priority given former soldiers does not exempt them from the requirements of farming experience and physical fitness.

News Continued on page 485

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Expansion Joint Failures

From Chief Engineer Samuel W. Marshall of the Pennsylvania Department of Highways comes the following full statement relative to the expansion joint failures and repairs on the George Westinghouse Bridge at East Pittsburgh (*ENR*, Aug. 26, 1937, p. 332):

The annual bridge inspection of 1936 and subsequent detailed investigation disclosed the failure of two of the expansion joints in the floor of the George Westinghouse Bridge, a five-span reinforced concrete arch viaduct, 1,525 ft. long, carrying the Lincoln Highway over Turtle Creek Valley at a height of about 200 ft. The bridge and the construction details were described in *ENR*, April 23, 1931.

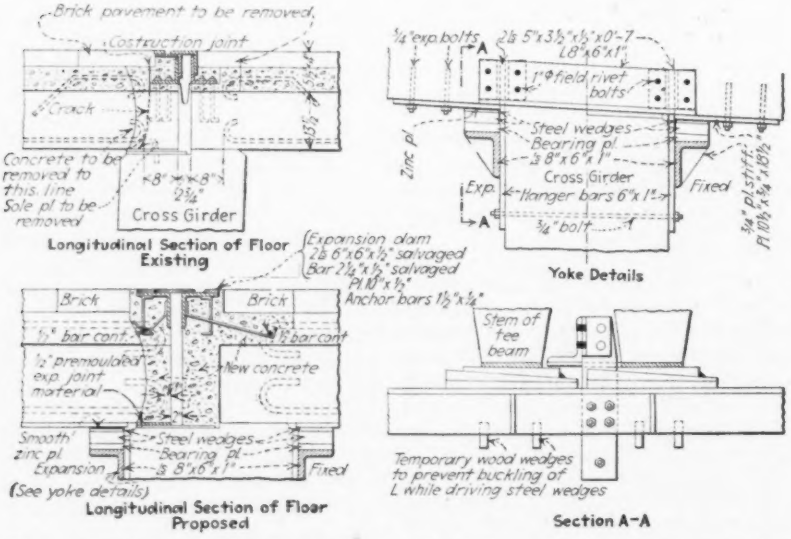
Expansion joints are located at the ends of spans only, and the failures occurred at the west side of Piers 1 and 4.

The construction of the expansion joints is clearly shown in the detail of the existing floor. The sliding joint consists of two ⅝-in. plates, one anchored into the bottom of the tee-beam stem and the other into the top of the cross girder by means of 1-in. round plugs set into the plates and extending 2 in. into the concrete. The contract called for the material of both plates and plugs to be a chrome-nickel-iron alloy and for the contact surfaces of the plates to be planed in the direction of movement. The floor concrete was poured with a vertical construction joint adjacent to the toes of the expansion dam angles. Note that the ends of the reinforcing bars in the tee-beams are approximately 8 in. from the ends of the floor sections.

The detailed investigation of the expansion joint failures disclosed the presence of vertical cracks in the concrete floor extending from the toe of the sole plate to the vertical construction joint adjacent to the end dam, approximately as indicated on the section by the dotted line. These cracks are just beyond the ends of the reinforcing bars in unreinforced concrete.

The cracks resulted when the "drag" on the sliding plates exceded the tensile strength of the concrete. The "drag" may have been greatly increased by corrosion of the sliding surfaces and partial "freezing". Also, the sections of concrete through which the cracks extend may have been weak because of the presence of air pockets or other defects. The causes of failure can be determined only by examining plates and concrete as repairs are being made.

Repairs will consist of providing an auxiliary support for the free end of the floor. This support will consist of a steel beam suspended from a yoke resting on the cross girder as shown on the accompanying details. Proper bearing will be secured by driving steel wedges under each tee-beam stem. All underfloor steel, being inaccessible for painting after erection, will be encased in concrete.



Floor expansion joint details in George Westinghouse Bridge showing existing condition which resulted in cracking and the proposed method of repair

Rackets a Possibility

Sir: I have been interested in the recent discussions in *Engineering News-Record* about engineers joining unions. While the principles of unionism are good in many ways, today the union movement has grown into a racket, shaking down the members for dues, initiation fees, assessments, etc. What do the members get out of it? In most strikes outsiders are brought in for picket duty—plug uglies, they are called—and the strike benefits paid the strikers wouldn't buy bones for their dogs.

Assuming there are about 4,000,000 organized workers in the country today that pay an average of $1 a month dues, plus initiation fees and assessments, the total annual kick-in is more than $48,000,000. If some of your advocates of engineers joining up will look over press reports of names of most union officials, they will find them largely of foreign extraction. The 100-per cent American is making it easy for these officials to live in luxury.

An illustration of unionism racket was called to my attention last week at a filling station in western Nebraska. A young man was telling the attendant that he had just come from California, where he had no trouble in getting a job at his trade as a baker. However, the C.I.O. demanded $125 before they would let him go to work, and he said he told them he would see them in Hell first, and was on his way home where he hoped there was still enough American freedom left so he wouldn't have to pay to a racket for the right to earn a living.

The engineering profession has always been underpaid, but if engineers join a union to get more pay, they

will find that initiation fees, dues, assessments and the increased cost of living that will come if they all become victims of the racket, will more than offset any increase. They will find themselves no better off than they are now.

Hagerstown, Md. THOS. SHEAHAN
Aug. 28, 1937

For Open Discussion

Sir: May I raise my voice in protest against those persons or group of persons who would like to gag your journal?

In the Sept. 2 issue, H. Mowry, Acting Secretary of Philadelphia Chapter of the Federation of Architects, Engineers, Chemists and Technicians, threatens a boycott of your magazine because of alleged attacks upon trade unionism for technical professionals. Several weeks ago there was another letter in which the writer censured you for publishing views which did not coincide with his. This strikes me as being a very narrow-minded and un-American attitude for so-called professional men to take.

Has it become a crime for an editor to express his views? I would consider it so if he refused me a chance to express my opinion just because I did not see eye to eye with him. This, certainly, has not been the case. I have been impressed with the fairness you have shown in publishing letters representing both sides of this question. *Engineering News-Record* should be a journal for the whole profession and not just for a few of us. Therefore, I beg of you to give us both sides of such questions.

Let's play the game fair and no hitting below the belt.

Buffalo, G. M. SCHELLER
Sept. 6, 1937

The Human Factor

Sir: Mr. Plowman has accurately described the principal weaknesses and shortcomings in the management of the municipally-owned waterworks (ENR Aug. 5, 12, 19), and he gives a clear outline of a desirable scheme for administrative practice. The latter is perfect in theory but impossible of attainment, so long as human nature remains unchanged. Wherever large sums of money are spent and many men are steadily employed at salaries and wages above the average, no matter whether the organization is owned and managed by city, state or nation, or by private agencies, there is bound to be a certain amount of extravagance, favoritism and waste. The manner in which these practices creep into industries varies with circumstances, but they are there, no matter how cleverly they may be concealed.

Theoretically, the personal interest in the financial success of any business should be sufficient inducement to the owners to develop an efficient organization, not to mention the incentive to an ambitious man of creating or building up a business. But in these days of holding companies, secret agreements and shrewd manipulation of stocks, there is too great a temptation to "get-rich-quick," and business management takes second place.

The above remarks are written merely to show that privately-owned enterprises have probably as many weaknesses to be criticized as publicly-owned utilities. Also, in most cases, municipally-owned waterworks give more satisfactory service to the public than those privately-owned. The principal reason why this is true is because the management of the former is under no obligation to show a profit at the end of the year, and usually is free not only to make such additions and changes necessary to maintain the service, but also to note the growth of the city, its probable use of water in the future, and plan to meet these probable demands as they arise.

It makes but little difference in the long run whether the municipally-owned waterworks is managed by a board of commissioners, by a single commissioner or by a utility district, because its efficiency curve of management (if it could be correctly plotted throughout its history) would doubtless show rises and falls the same as we see in all curves showing progress, although the general trend would be upward. The reason for this brings us back to the same cause stated in the beginning of this letter, namely, the factor of human nature.

The St. Louis waterworks has been owned and operated by the city for more than one hundred years. Its management at various times has been under the direction of individuals subject to the orders of the mayor, or the city council or both, to a board of commissioners, to one commissioner appointed by the mayor, and since 1914 has been a division under the director of public utilities, who appoints one commissioner who is responsible to the director.

The history of this waterworks, I think, is in general the same as of all others—a succession of periods of activity and of lassitude, where for a while improvements would be pushed forward by an energetic and able manager with a keen eye for the proper and economical administration of existing facilities. Then after this period of unusual activity, things would lapse into a monotonous routine and efficiency would gradually decrease with a change of administration, and continue until some occurrence would awaken the public to a necessity for improvement in the system, or until by chance some able and energetic man would see the necessity of instant action in order to meet near future demands.

St. Louis, Mo. EDWARD E. WALL
Director of Public Utilities

Stream Pollution Legislation

Sir: Referring to your editorial on stream pollution legislation (*ENR* Aug 26, p. 339), I fully agree that if the result of this proposed legislation "is the virtual paralysis of state authority over sanitation . . . . this would be a great loss to sound public administration in view of the enviable record of efficiency that state sanitary activity has made." The consistent experience of the Public Health Service in its cooperative health activities with the states has been that federal interest and financial assistance has served to stimulate and develop state and local interest in public health matters.

Many persons expressed concern lest the $8,000,000 for grants-in-aid to states for public health work under the provisions of the Social Security Act would tend to discourage local interest and to dry up local appropriations. Exactly the reverse has been the case. Not only have the federal funds been matched dollar for dollar, but new state and local appropriations have been made in amount approximately equal to the federal grant.

Washington, D. C. THOMAS PARRAN
Aug. 30, 1937 Surgeon General
U. S. Public Health Service

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DEDICATION OF WHEELER DAM marks the second step in the colossal but vague undertaking of the Tennessee Valley Authority. Wheeler, like its predecessor Norris, is a step toward complete control of the Tennessee, and brings into the spotlight the fact that the TVA enterprise is purely a river development project. The extraneous elements tacked onto this central purpose have failed to show any promise of constructive accomplishment. The aggressive public-power program has floundered for four years; the attempt to bring about soil improvement and to uplift the Valley farmer by subsidy leverage still awaits proof of general usefulness. The river remains the focal point of constructive effort—effort to conserve flow, control floods, improve navigation possibilities, and realize opportunities for power generation in harmony with these purposes. Yet, though part of a long program has been completed, nothing approaching a schedule of benefits and costs has been presented by the Authority. After four years of investigation and construction it should be able to present such a balance sheet. Unless it soon does so, the enterprise cannot long retain public support; and its failure may drag down with it the whole concept of basinwide stream control, already badly shaken by the federal holdup of the New England compacts.

Local Revival

FOR MANY YEARS the trend of engineering organization has been in the direction of nationalism, somewhat as in governmental affairs. An early result was to build larger national societies; the local engineering groups lost vitality and the close fraternity of engineers that springs from personal contact in local societies was weakened. The profession as well as the individual was the loser thereby. Now that engineering is troubled by unionization movements and related questions that in last analysis trace back to absence of mutual understanding, the time may be ripe for return to the older custom of local association. As a matter of fact, the need has already been recognized in some cities, where efforts are under way to bring the local professional membership into closer contact. But to be effective this movement must become more general. It would be helpful if the active groups were to record their experience and success, since examples of success in local organization cannot fail to be both instructive and inspiring.

Cooperative Research

THE UNIQUE ARRANGEMENT for research in sanitary engineering that has just been inaugurated by New York University and the city of New York has much to commend it as creating a new municipal agency and strengthening the university's engineering school. The city has built a large laboratory for water and sewage research on a part of the campus that the university deeded to it, and has turned direction of the laboratory over to the university. The university thus gets a much better laboratory than it could otherwise obtain, in which it can give its students close contact with practical research problems. In return the university will provide special training for men selected from the engineers of the city's department of sanitation. Also, the city should be enabled to arrange for research beyond the limits of a laboratory set up in the city's sanitation department itself. If the city's requirements are so managed that they will not dominate the laboratory and interfere with studies going beyond the local problems of sanitation, the cooperative arrangement should prove beneficial to the city, to industry and to the university student alike.

Toward Useful Service

THOUSANDS OF YOUNG MEN are enrolling in the engineering schools this month to prepare for a professional career. Rightly the entering student may ask what result is before him, what ultimate accomplishment he may achieve. The question has meaning to the profession as well as to the student himself. The instructor or engineer to whom the student may appeal will of course tell him that in part the outcome of his college training depends both on the genius of the teacher and on the receptivity and effort of the student. But if he is wise he will also point out that the student's own objective is a decisive factor. Does the beginner wish to become an engineering craftsman, or this or that kind of engineer? Is he seeking an easy road to material prosperity? If so, the forecast may well be that the student will fail, or at best will serve to dilute the profession. Or, on the other hand, does he desire to become not some type of craftsman but an engineer, member of a profession that is devoted to the useful service of construction? Is he prepared to engage in working out human problems on the basis of measured fact and in discovering how physical obstacles may be overcome in the interests of the world's progress? If so, he has the

true key to the study of engineering. With this beginning supplemented by intelligence and effort, he may confidently look forward to becoming an engineer.

National Public Works

FOR MORE THAN A DECADE engineers have discussed the establishment of a federal public-works department which would carry on the nation's major construction and bring under unified direction the allied engineering operations, such as the surveys and water measurements. The plan made no progress, however, and national engineering and construction work continued to be carried on piecemeal. Now the subject again comes to the front in an official report of the Brookings Institution to the Senate committee on government reorganization.

Unfortunately the recommendations of the report are inconclusive with respect to the formation of a public-works department, and definitely opposed to including engineering in any works agency that may be set up. Aside from some shuffling of bureaus, the report would do nothing to centralize construction beyond placing major building operations in one bureau. Thus the report contributes little to better organization of our extensive national engineering activities.

Construction by a multitude of separate groups without coordination or unity of procedure is known to be inefficient, and the practice of many governments as well as of large corporations abundantly demonstrates the advantage of centralizing works and engineering in a single authority. In the face of the Brookings Institution's nonconstructive finding, it is therefore timely to repeat that the first item of administration of public affairs is efficient organization of national works and engineering. But the difficulties that arise from the complexity and magnitude of the federal operations should not be overlooked.

It is to be noted that the planning of an improvement will often originate with the administrative department concerned, which necessarily first feels the need for the improvement. Further, before the need can crystallize into a project, it must be studied to define the desired improvement and find out its advantages and costs. The operating departments therefore will have to retain their own engineering divisions. Similarly, they will have to carry on their own maintenance, up to the point where major reconstruction begins. Thus, centralization of engineering functions has natural limits.

It is also logical that technical bureaus whose functions are administrative, like the Bureau of Public Roads, the Federal Power Commission and the Interstate Commerce Commission, be kept clearly distinct from the works organization. Their necessary technical auxiliaries could hardly be effective if separated from the administrative organization.

Whether and to what extent it may be advantageous to keep apart from a general works department such integral activities of major size as river improvement, reclamation or harbor construction, also deserves consideration. These major groups of work, now carried on at high efficiency, have less to gain through centralization than the large number of construction activities now scattered throughout the government's structure.

Difficulties and problems of this kind are unavoidably present in so large an undertaking as that of setting up a public works department. Nevertheless, the basic fact remains that sound public business demands a well-knit organization to carry on the national government's increasingly important engineering and construction work.

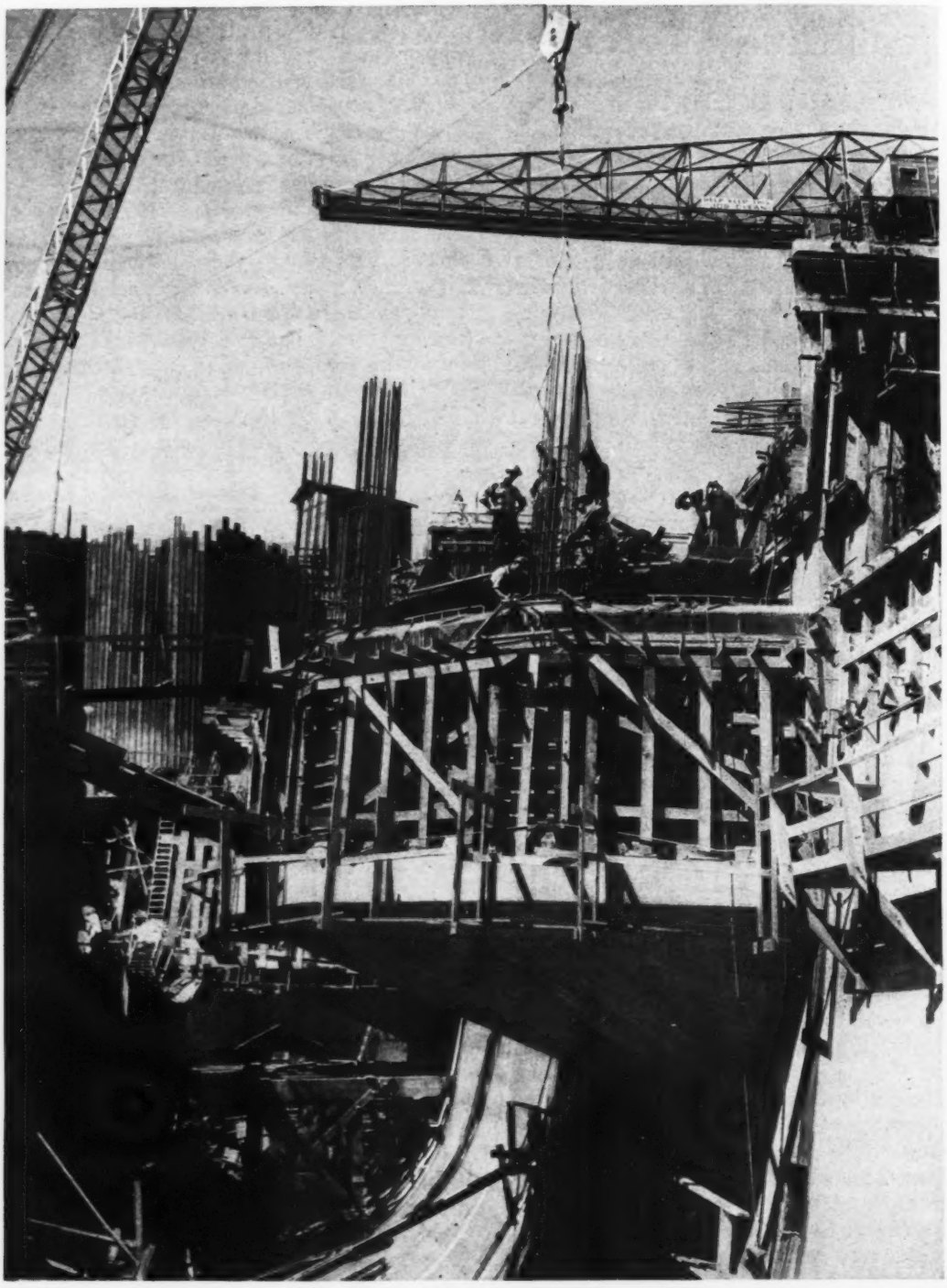
Progress in Treatment

THE HIGH STATE of development that water purification has attained may at times suggest that treatment practice is a cut-and-dried procedure involving tanks, filters and other standard processing equipment which differ only in size for each installation. But examination of developments in treatment will quickly reveal that in the detailed design and application of accepted processes many significant departures from so-called standard technique are made. These improvements in method, leading to better water quality at lower cost, dispel any notion that water treatment is a static art.

In the special section on waterworks in this issue are examples of important recent advances. Particular interest resides in the novel treatment plant of St. Petersburg, Fla. Departing from usual design practice in order to maintain the required hydraulic conditions in the water-supply system, all the treatment devices have been housed in welded steel tanks above ground. In this case not only were new precedents established in design, but the method of operation as well incorporates new thinking. More conventional in design, but featured by a number of striking innovations, the new purification plant of Covington equally invites attention.

In brief, when one considers the progress achieved during the last few years in water treatment practices the rate of advance becomes impressive. It is only necessary to recall the improvements made in coagulation, in taste and odor control, in softening, in corrosion control and in filter operation. To the waterworks technician these developments signalize ever closer approach to the perfection he strives to achieve, and give assurance that the art will never become static.

PICTURES IN THE NEWS



"BAY WINDOWS" are being built on the upstream face of Grand Coulee Dam to support trash racks at entrances to the water passages through the dam. The racks protect water passages at three levels, El. 934, 1,034, and 1,134, twenty racks at each level and each screening two openings. The total capacity of the 60 outlets will be 273,000 sec.-ft.

FIG. 1. CLUSTER OF STEEL TANKS HOUSING THE WATER TREATMENT PLANT SERVING ST. PETERSBURG, FLA.

Water Treatment In Steel Tanks

by MALCOLM PIRNIE
Consulting Engineer, New York, N. Y.

Design features of the novel treatment plant in which softening, coagulation and filtration operations are housed in a cluster of welded steel tanks

SPECIAL CONDITIONS which dictated the economy of providing water treatment on an hydraulic grade substantially above ground surface elevations led to the use of steel tanks for the Pinellas Water Co. plant, which supplies St. Petersburg, Fla. Housed in welded steel tanks are the aeration, softening, coagulation and filtration units, and also the chemical storage and feeding equipment. This novel plant is an extension of water service facilities, the original installation of which was made in 1930.

The raw water supply to the plant comes from 12 wells which tap the Ocala and Tampa limestone formation at Cosme. These wells, installed in 1930 (*ENR*, Sept. 11, 1930, p. 402), are equipped with deep well pumps operated by pushbutton control. Water is delivered to a spray nozzle aerator supported on the roof of a 50-ft. dia. steel tank; the nozzles are at El. 64. From here the water is carried in a 36 in. concrete pipe line for a distance of 22½ mi. to a steel storage tank located just outside of St. Petersburg (*ENR*, May 21, 1931, p. 842). The flow line of the tank is at El. 52.25 and the ground is at El. 11.25. Thus with a full tank under the aerator at the well field, a gravity flow can be carried to the storage tank varying from 5 to 6.5 m.g.d., depending on the amount of water already in storage.

When it was decided to install softening facilities in 1935 the first important problem presented in the design was that of interfering as little as possible with the hydraulics of the system. The ground level in the vicinity of the well field aerator tank is about El. 42.5, and this required the construction of tanks which would hold the water at a flowline slightly over 20 ft. above the ground. In these circumstances, the most economical material available for construction of the plant was steel.

A softening plant was desired, at a cost not to exceed $100,000, which would convert the well water containing 200 p.p.m. of bicarbonate hardness into a filtered water of 100 p.p.m. total hardness. On the basis of laboratory experiments it was determined that the desired results could be secured by softening 60 per cent of the aerated water with lime and bypassing 40 per cent of the surface aeration; the latter was to be treated with ferric sulphate in a dose sufficient to coagulate the mixture of lime-

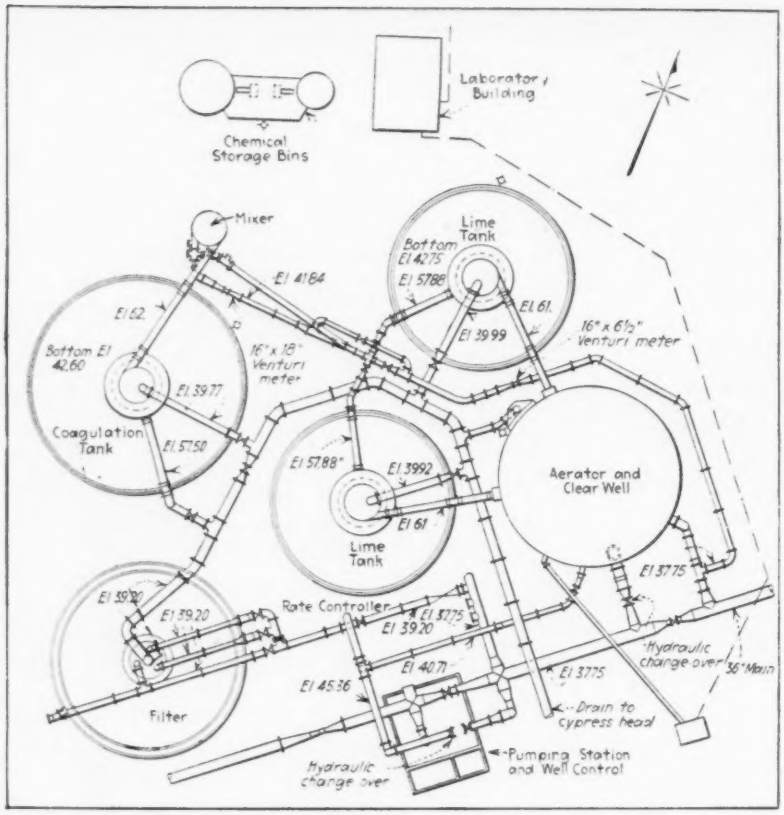


Fig. 2. General layout of the plant which provides aeration, softening, coagulation and filtration facilities.

softened and bypassed waters. It was anticipated that the retention of free carbon dioxide in the bypassed raw water plus the carbon dioxide freed by the reaction of the ferric sulphate with the bicarbonates in this water, would produce the necessary amount of recarbonation of the lime-softened portion of the supply.

The energy in the bypassed water in excess of that remaining in the aerated water delivered to the softening tanks is used in a modified eductor type of mixer to create a thorough mixing of the water and to compensate insofar as possible some of the head losses occurring in the process of softening and filtration. The roof of the existing areator tank was sealed in order to convert the storage below the roof into a clear water storage basin, and the aerated water is collected in two chambers welded to the freeboard of the tank which forms the wall of the aerator basin; rectangular holes connecting with these chambers were burned through the walls.

Water from these chambers is carried horizontally through tangential connections to 10 ft. dia. center-wells which are constructed in the two 50-ft. dia. welded steel tanks set on the ground at El. 42.75. (Fig. 3). Close to the bottom of each center-well 40 steel nipples were inserted in holes evenly spaced and welded to the center-well plate. Radial pipes, perforated with sixteen ¾-in. holes were attached to the nipples and the pipes were so spaced that each concentric ring of holes served equal areas of the bottom of the tank.

A 24-in. drainpipe connection was built under the floor of the tank to an elbow connecting with the center-well. This pipe was backfilled with concrete which served both as foundation and bottom of the center-well, the plates of which extended into the finished surface concrete 18 in. below the floor level. The tank floor plates were welded to the outside of the center-well and were laid flat upon a smooth sand surface. The center-well drain was carried through a gate to a 30-in. cast-iron main drain which discharges to a nearby cypress head.

At the top of each center-well a doughnut-shaped collar was welded with holes evenly spaced through the outer ring to admit water from the upper part of the tank. The tank effluent is collected in these collars and delivered through a control gate to a pipe which conveys the lime-softened water to the mixer.

Ferric sulphate mixer

The mixer consists of a 10 ft. dia. welded steel standpipe 24 ft. high with three 20-in. pipe connections welded one above the other in the same vertical plane tangential to the side of the tank. (Fig. 3). A ring is welded inside each pipe connection to provide a permanent orifice with a diameter of 14¾ in. Special steel crosses 20x16 in., are attached to each connection. The softened water is delivered from a header through one 16-in. connection to each cross, the opposite 16-in. connection being covered with a blank flange. (Fig. 5).

The bypassed raw water containing the ferric sulphate is delivered to a header with 12-in. connections carried through the 20-in. flange of each tee and reduced immediately to an 8-in. pipe inside the 20-in. connection to the stand-pipe; pipe caps with orifices of various diameters are provided for the ends of the 8-in. nipples.

The volume of the ferric sulphate-dosed raw water jet is controlled by the size of the 8 in. cap nozzle and the head on the aerator. The flow of softened water is controlled by the number of aerator nozzles operating under this same head. The equipment provided on the mixer, therefore, permits a fixed proportion of mixing at various rates of draft. This is done by operating one or more of the mixer connections and by varying the number of nozzles open in the aerator or the head at which the water is delivered from the wells. The combined water in the mixer rises in a turbulent revolving motion to a tangentially-connected discharge pipe 24 in. in dia. This pipe leads through the outer ring of a 60 ft. dia. coagulation tank to a tangial connection with a 10 ft. dia. center-well.

Coagulation tanks

The design of the coagulation tank is similar to that of the lime tanks just described. The dosed water is delivered through radial transite pipes

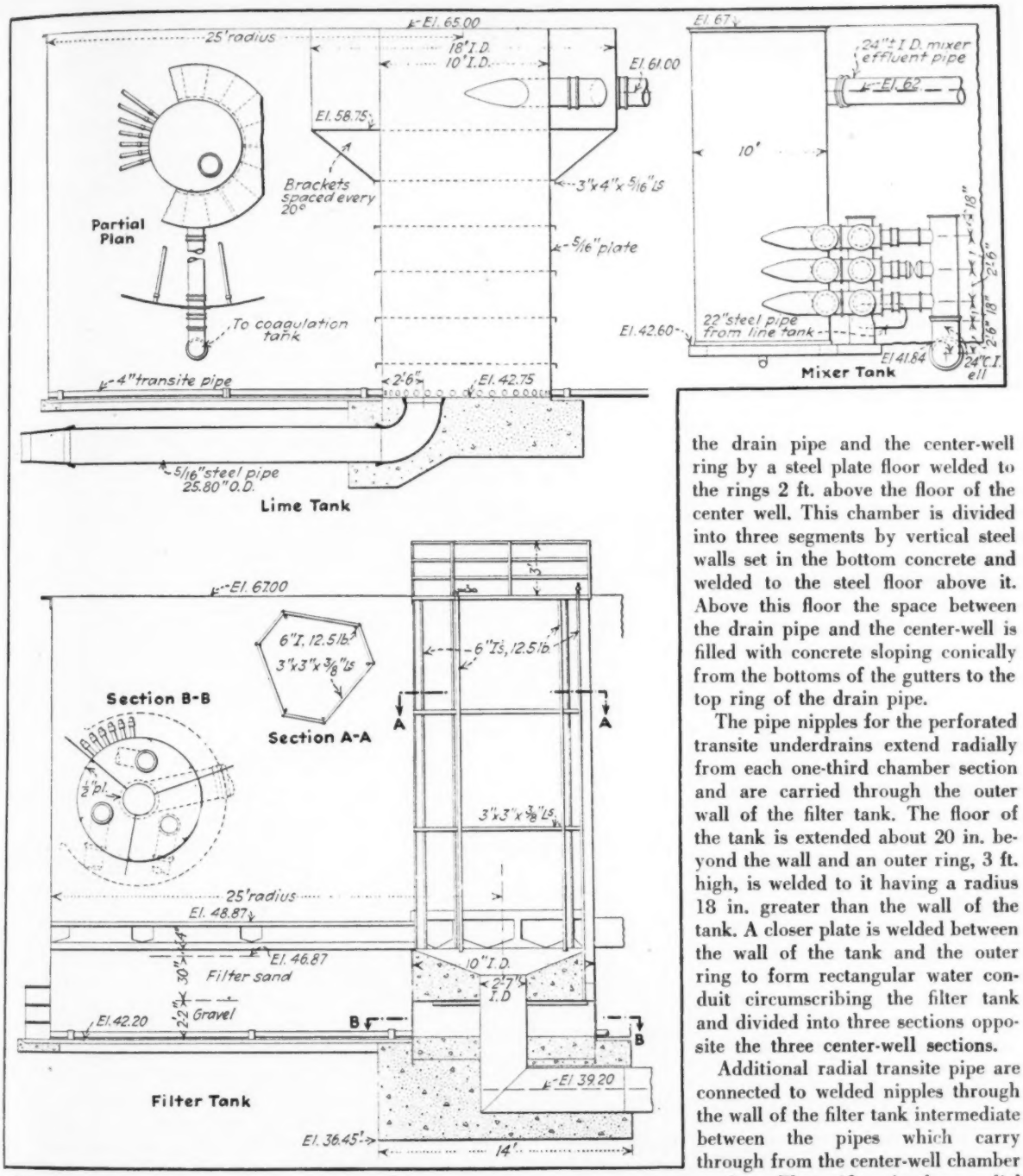


Fig. 3. **Design details of the welded steel tanks showing the arrangement of the lime softening, filtration and mixer units.**

perforated to deliver the water evenly to the bottom area. The water rises vertically to a settled-water discharge into a perforated steel ring at the center of the tank from which it is conveyed through a 24-in. pipe to a connection with the main drain. The end of this drain serves the dual purpose of washwater drainage from the filter and introduction of settled water.

The filter tank (Fig. 3) is a welded steel tank 50 ft. in dia. and 22 ft. high. Its center-well is carried from the concrete ring connection located construction at the tank bottom to the top of the filter gutters. The drain pipe is carried vertically in the center to a level below the bottom of the filter gutters; a chamber 2 ft. high is formed between the outside walls of the drain pipe and the center-well ring by a steel plate floor welded to the rings 2 ft. above the floor of the center well. This chamber is divided into three segments by vertical steel walls set in the bottom concrete and welded to the steel floor above it. Above this floor the space between the drain pipe and the center-well is filled with concrete sloping conically from the bottoms of the gutters to the top ring of the drain pipe.

The pipe nipples for the perforated transite underdrains extend radially from each one-third chamber section and are carried through the outer wall of the filter tank. The floor of the tank is extended about 20 in. beyond the wall and an outer ring, 3 ft. high, is welded to it having a radius 18 in. greater than the wall of the tank. A closer plate is welded between the wall of the tank and the outer ring to form rectangular water conduit circumscribing the filter tank and divided into three sections opposite the three center-well sections.

Additional radial transite pipe are connected to welded nipples through the wall of the filter tank intermediate between the pipes which carry through from the center-well chamber sections. The orifices in these radial underdrains are so spaced that they serve equal areas of the bottom of the tank. Each segment of the chamber in the center-well is connected with its opposite segment in the outer circuit by pipes laid under the floor of the filter tank; hydraulic gates control these connections. Beyond these gates the pipes connect to a single 20-in. effluent pipeline.

Between the filter and the effluent control gate a 20-in. connection is

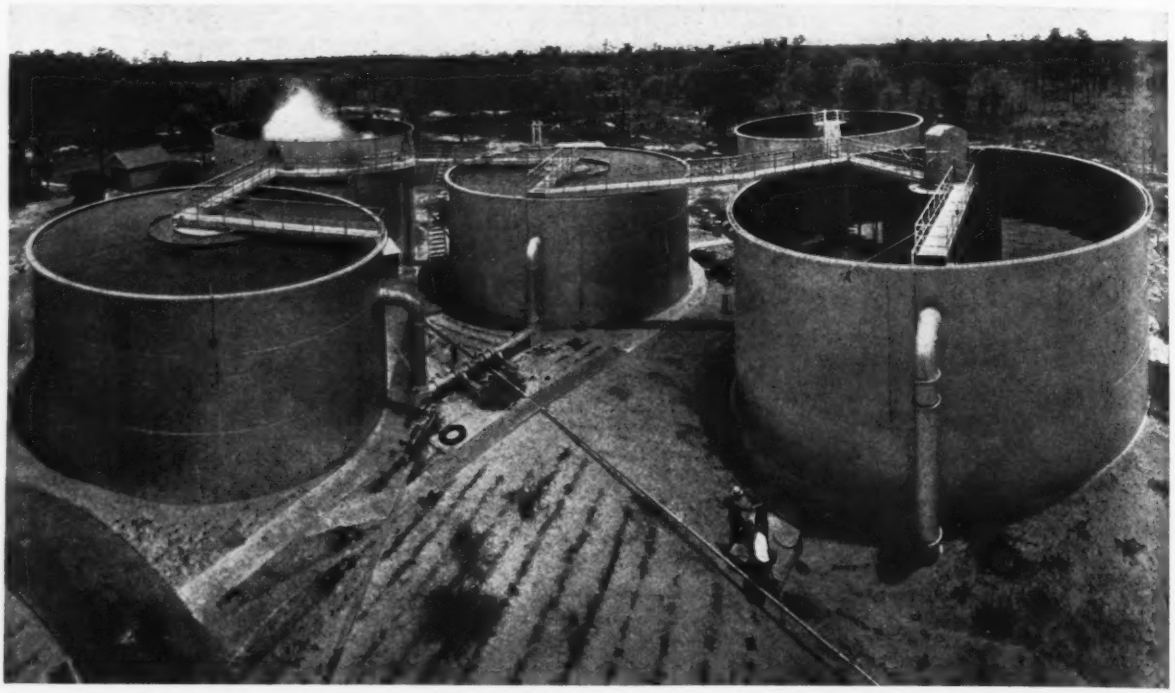


Fig. 4. Treatment units in the plant, reading from left to right, are: lime softening tank, aerator and filtered water storage, lime softening, filter unit, and coagulation tank. The mixer standpipe had not yet been installed.

made through a gate to the discharge from the washwater pump. Beyond the control gate a controller is provided just before connection is made with the 36 in. supply main to the St. Petersburg storage tank. Control of the rate of filtration is guided by an operator at the storage tank station, over 22 mi. away. When the filter requires washing, the hydraulic valve at this station is closed, the influent valve to the filter from the coagulation tank is closed and the well field booster pump is operated to draw the water above the sand level in the filter down to the level of the washwater gutters. Enough of this water to fill the filtered water reservoir under the areator is supplied through a pipe connection to the washwater line, and the balance of the water is delivered to storage. The filter is then washed in three sections, after which the three gates controlling the pipe systems of the three filter segments are opened, the booster pump is shut down and normal operation of the plant resumed.

Normal flow of the water for sedimentation in the lime tanks and the coagulation tank is upward through the precipitated materials. When desludging is required the connection to the drain from any one of the tanks is opened for a few minutes, thus allowing a discharge through the orifices of the radial pipe system at the bottom of the tank under the full head of water in the tank which is in excess of 20 ft. The operation requires only a few minutes each day on the lime tanks and once a week on the coagulation tank.

Chemical storage and feed

Chemical storage and housing for the feed equipment is provided by two welded steel standpipes. Conical bottoms of the storage bins are at a sufficient height above their concrete foundations to permit the installation of the chemical equipment below them. (Fig. 5) Weighing hoppers are mounted directly under the bottom of the storage bins and these discharge through dry feed machines into the solution apparatus. The smaller standpipe has capacity for a year's supply of anhydrous ferric sulphate which is delivered to the storage section by its own bucket elevator. The larger standpipe used for lime, has a capacity of two carloads and is also filled by means of a bucket elevator.

Ferric sulphate is fed into a rubber lined tank in which a 40 per cent solution is kept agitated by a motor-driven paddle. The overflow is carried to a second rubber-lined tank where it is diluted and then picked up through a perforated rubber hose connected to the suction of a glass eductor. The eductor discharge is carried through a rubber hose to a glass tube inserted in the raw water line through an insertion cock. This system, after various other methods have been tried, has proved to be thoroughly reliable and requires a minimum of attention.

A dry-feed lime slaker is installed in the base of the larger standpipe. Lime water, flowing through an open channel to a steel receiving well set in the ground near the aerator tank, is discharged through an eductor leading into a straight riser pipe to the level of the areator tank platform. The flow at this point is divided into two conduits which deliver the lime through drop pipes into the center-wells of the tanks at the point of tangential introduction of the aerated water.

Operating results

The filter is operated at a rate of approximately 2.5 gal. per sq. ft. per min. when delivering 6.66 m.g.d. or $\frac{1}{3}$ the capacity of the pipeline. At this rate there is a total loss of head between the water on the aerator floor

and the water level in the filter of approximately 2.5 ft. When operating the plant at a rate of 7.3 m.g.d. the head loss goes up to 3 ft.; operating at 3.5 m.g.d., the loss is only 2 ft.

The distributor pipe system in the bottom of the lime tanks was made of perforated transite pipe and there is a gradual incrustation of calcium carbonate on the sides of the holes.

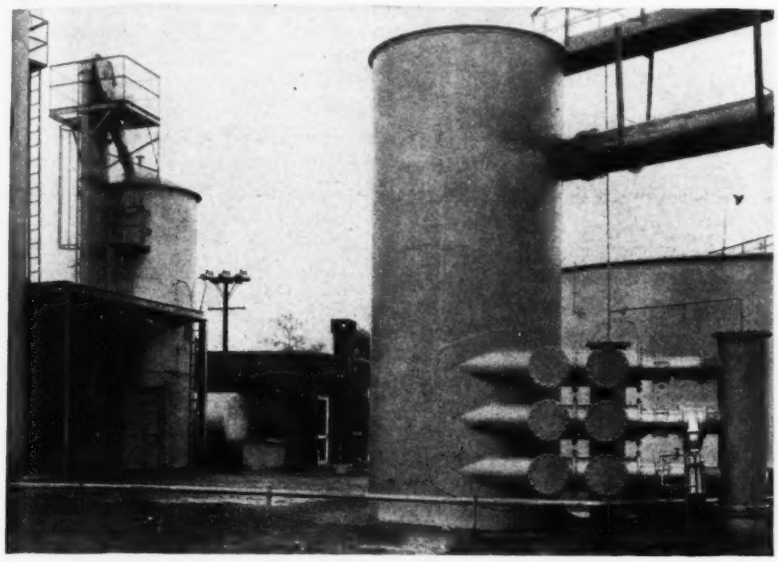


Fig. 5. Mixer tank with special welded connecting pipes. At the left are the chemical storage tanks.

At rates of operation from 3.5 to 7.5 m.g.d., which require a flow of aerated lime-treated water to the tanks in parallel at rates of from 2.1 to 4.5 m.g.d., the lime tanks are 100 per cent effective in removing the turbidity from the treated water. The suspended sludge can be seen readily at a depth of more than 7 or 8 ft. below the surface.

The ferric sulphate dose is maintained at about 0.6 gr. per gal., based upon the total raw and softened water supply to the coagulation tank, and is not sufficient to produce a visible floc in the mixer water delivered to the coagulation tank. However, contact of this water with the previously precipitated ferric hydroxide floc produces satisfactory results in the upward flow coagulation process. Some of the lighter floc is carried over to the filter at the higher rates of operation, but filter runs are satisfactory considering that 7 m.g. of water are filtered between washes at a final loss of head not in excess of 6 or 7 ft.

The outstanding features of the St. Petersburg softening plant may be summarized as: (1) a design adapted to water treatment on an hydraulic grade substantially above ground surface elevations; (2) the demonstrated effectiveness of upward flow sedimentation which apparently aids materially in the completion of the chemical reactions; (3) the ease with which sludge can be removed from the various basins without interruption of service; (4) the use of a ferric salt added to a portion of raw water to augment the free carbon dioxide of the raw water by that released from the reaction with the bicarbonates contained in it to effect recarbonation of the softened water; and (5) the relatively low expense of a plant of this type in producing a water with a hardness of about 100 p.p.m. from a raw water having a bicarbonate hardness of 200 p.p.m.

Operating results from January to July, inclusive, 1937, show that the average amount of lime applied to 60 per cent of the water softened has been 1076 lb. per m.g. or 646 lb. per m.g. of the total water supply. The ferric sulphate dose to the 40 per cent of raw water bypassed has averaged 247 lb. per m.g. or 99 lb. per m.g. of the total water. The average methyl orange alkalinities and soap hardness were respectively 183 and 180 p.p.m. for the raw water and 90 and 99 p.p.m. for the filtered water. The average pH of the filtered water was 7.9. Color of the filtered water has not exceeded 5 p.p.m. and analyses of the effluent show but a trace of iron.

The final cost of the plant, including the laboratory building, roadways, etc. was about $134,000.

The writer designed the present plant as well as the original installation made in 1930. All the steel tank work was constructed by the Chicago Bridge & Iron Co., and the piping and concrete work was installed by W. D. Berry, Inc., St. Petersburg, Fla.

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Sodium Compounds For Coagulation

THE pH zones of floc formation of sodium aluminate and sodium zincate have been determined in distilled water and in synthetic water containing varying concentrations of the sodium, calcium and magnesium, chloride, sulphate, and bicarbonate ions. In the case of both coagulants, according to a paper at the American Chemical Society meeting Sept. 7 by A. P. Black, R. A. Bardwell and B. W. Graham, the zone of floc formation in distilled water is quite narrow.

The chloride ion is bound to exert little effect on either coagulants. The sulphate ions have little effect in the case of sodium zincate but broaden the zone for sodium aluminate on the acid side. Both the calcium and magneisum ions broaden the zone of floc formation for each coagulant on the alkaline side and have pH values too low for the precipitation of magnesium hydroxide to occur.

The two coagulants were compared with respect to the reduction in residual hardness to obtained over that when no coagulant is used. Sodium aluminate exerts no appreciable effect in case of water containing only calcium hardness but exerts significant effects in the case of water containing magnesium hardness. With high magnesium waters, sodium aluminate and excess sodium carbonate reduce residual hardness.

Sodium zincate, on the other hand, is of little value in reducing residual hardness of either type of water. A slight reduction is noted in the case of waters high in magnesium hardness, but for high calcium waters the residual hardness is increased over that obtained when no coagulant is employed.

Filtered Water for Covington

by J. Stephen Watkins
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Ohio River supply will be treated in new plant employing top and bottom filter wash, lime-soda softening and automatic chlorination

The largest community still using unfiltered water from the Ohio River—Covington, Ky.—will abandon this practice on October 15 when a 20-m.g.d. purification plant is placed in service. The new plant embodies several interesting design features including a combined top and bottom filter wash system, and a varying cross-section influent distribution flume which provides even flow through full width of the tanks. In addition to filtration the plant provides facilities for lime and soda softening, the use of activated carbon for taste and odor control, and automatic ammoniation and chlorination.

Covington supplies water to all the northern Kentucky communities adjacent thereto, except the city of Newport and the towns of Bellevue and Dayton. The population of the city, together with that of the outlying communities served, is about 95,000. In addition to the domestic needs, there are numerous industrial and manufacturing plants which require large quantities of water. Most important of these, from the standpoint of consumption, is the Standard Oil Co. refinery at Latonia which at present uses 5 m.g.d., but has requested permission to increase the daily draft to 8 m.g.d.

The water supply is taken from an intake on the Ohio River in which there are two 7,000 g.p.m. electrically-driven centifugal pumps located in a dry well. Previous to the construction of the new plant, the water from these pumps was carried through 4,000 ft. of 30-in. main to a chemical building, at which point lime and alum were added as coagulents. The water then flowed by gravity from the chemical building to two sedimentation basins holding about thirty-five million gallons each. From these basins, located about 380 ft. above the level of the river, water flowed to a third basin 25 ft. below, from which point it was drawn off by gravity for the city's supply.

These three reservoirs were constructed in the period 1887-89 under the direction of G. Buscaren, consulting engineer of Cincinnati.

The new purification plant has been designed with the idea of using the two upper reservoirs as plain sedimentation basins; the third reservoir was found to be the only satisfactory location for the filtration plant. The portion of this reservoir located immediately under the filtration plant is being used as a clear well. All the structures of this plant are supported on columns from the bottom of this old reservoir which will be backfilled with the exception of the clear well and other occupied portions.

In studying the design of this plant with the view of economy in operation, it was found desirable to separate the chemical building and filtration plant, the former being

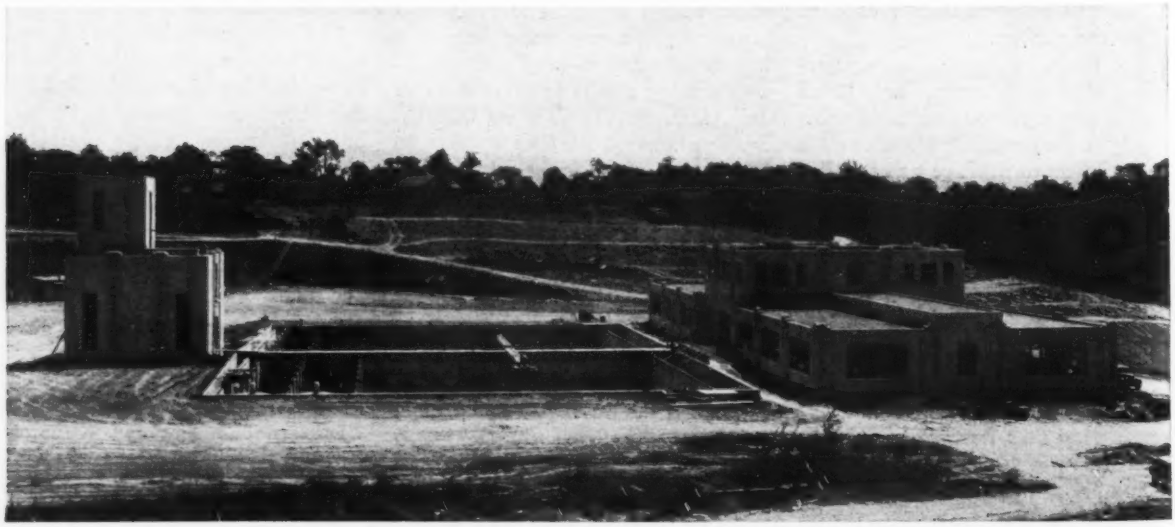


Fig. 1. Structures of the Covington purification plant are supported on columns from the bottom of an old reservoir which was backfilled with the exception of a portion under the filters (right) which will be used for clear water storage.

located at the end of the old reservoir nearest the two remaining basins. The coagulation and settling basins lie between the chemical building and the filtration unit; the latter, with a capacity of 19.2 m.g.d., is placed at the outlet end of the old reservoir.

The water from the Ohio River varies greatly in turbidity. At pool stage the turbidity is normally 10 to 20 p.p.m., but after summer freshets and at flood stage it often reaches into the hundreds and even thousands parts per million. It was considered desirable, therefore, to retain the two upper reservoirs as primary sedimentation basins. This will provide a detention period of from four to seven days during which the heavier suspended matter can settle and thus furnish a raw water supply of more uniform character than could be obtained by pumping directly from the river.

The present chemical building, located above these two sedimentation basins, will remain and, while it is not intended to use chemical precipitation for these sedimentation basins, it may be found advantageous in emergencies.

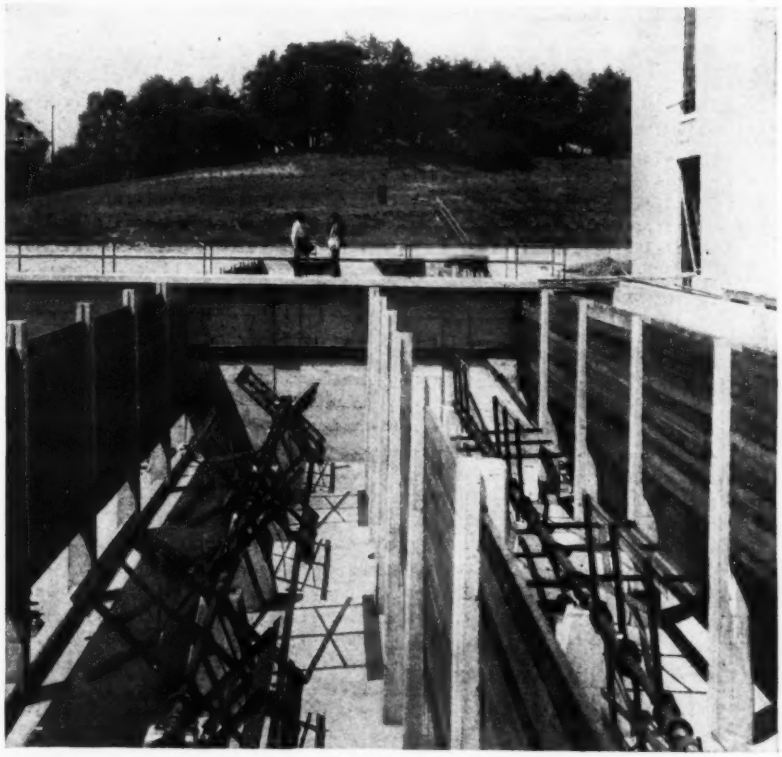


Fig. 3. Coagulation basins are divided into two compartments separated by redwood baffle walls, and fitted with paddle flocculators.

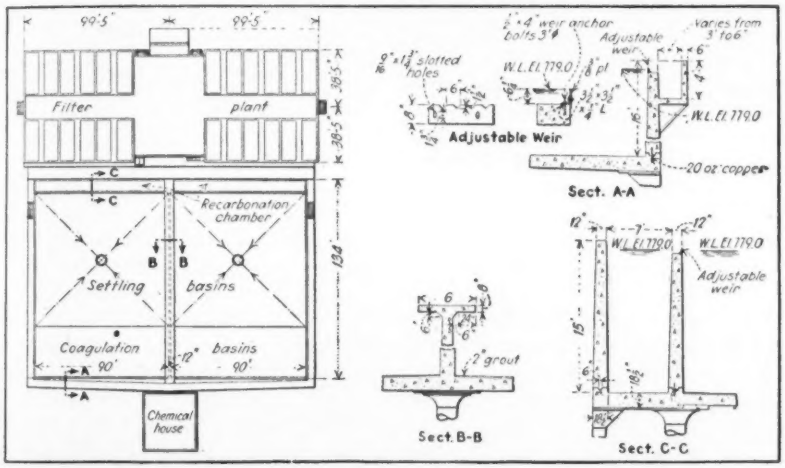


Fig. 2. General layout of the plant, and details of the tanks showing the inlet flume and wall section design.

Treatment processes

Water from the two upper reservoirs and also that from the river pump line is carried to a common valve pit in which are located three electrically-operated valves. These valves, controlled from station in the filter plant, permit the withdrawal of raw water from either basin or directly from the river. From the valve pit the water passes through a venturi meter to a quick-mix basin in the chemical building.

Chemicals will be delivered to a storage building in trucks and dumped into a receiving hopper from which point they will be carried by a pneumatic conveyor to the bins located above the feeding machines. Sufficient storage is provided for a carload of each of the chemicals used. The chemical feeders are connected to the bins with dust-proof extension hoppers and provided with hopper-type scales so that the exact amount of chemicals used can be determined.

Alum will be used as the coagulent, with lime added to correct the pH value of the water. Excess lime and soda-ash softening, with recarbonation after sedimentation, is also provided. The hardness of the Ohio River water at this point is usually around 100 p.p.m., but when the river remains at pool stage for any great length of time the hardness often increases to a point in excess of 200 p.p.m. Under normal conditions, the plant will be operated so that the hardness of the finished water will be maintained at about 100 p.p.m.

Activated carbon will be used to control tastes and odors in the water. The feed is so arranged that carbon can be applied to the quick-mix basin or in the filter influent flume between the recarbonation chambers and the filters.

From the quick-mix basin water is carried through two 36-in. pipes which are provided with sluice gates to control the flow to either or both of the coagulation and sedimentation

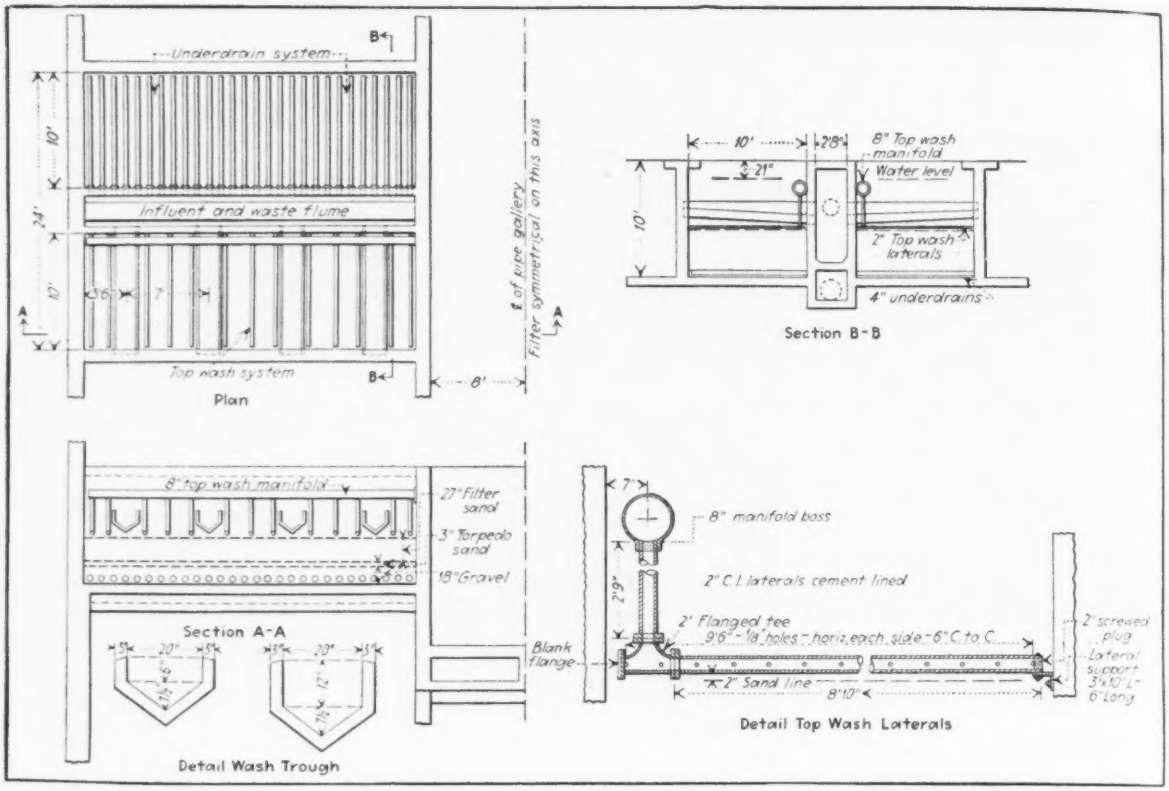


Fig. 4. Filter wash system details showing the arrangement of the combined top and bottom sand washing devices.

basins which are arranged in parallel. The coagulation basins are provided with concrete flumes across the entrance ends so that the water enters at the end of the flume near the division wall between the two basins. In order to provide an even flow of water throughout the entire width of the coagulation basins, a flume of varying cross-section has been provided across the end of each coagulation basin. An adjustable steel plate weir is also provided so that the level of the water in the flume may be maintained at a slightly higher elevation at the inlet end of the flume than at the outlet end.

The coagulation chambers are 34 x 90 ft. in plan, with a 15-ft. water depth. In these chambers are two rows of paddles revolving about a horizontal axis in such manner that the paddle at the lowest part of its revolution is traveling toward the incoming water. The coagulation chambers are provided with redwood baffles to prevent short-circuiting, and are separated from the sedimentation basins by baffles which promote the flow of water across the entire width of the basins.

The sedimentation basins are square, each being 90 x 90 ft., with a 15-ft. water depth. These basins are provided with rotary sludge scraping equipment which permits continuous removal of the sludge. It is recognized that there will be some dead corners due to the use of square basins, but the square design fitted this particular location to a much better advantage than either the round or rectangular.

When operating at normal plant capacity the detention period, using both coagulation basins, will be 68 min., and the velocity 0.66 ft. per min. The detention period in the settling basins will be two hours and twenty-seven minutes, and the velocity of travel, 0.66 ft. per min.

For preammoniation and prechlorination, manual feed machines have been provided.

The quick-mix basin, located below the floor of the chemical building in the end nearest the coagulation chambers, has a detention period of about 2 min., based on normal plant capacity.

The structural design of the coagulation and settling basins is rather unusual insomuch as the basins are supported by spirally reinforced concrete columns and are of flat slab construction. The exterior walls are designed as cantilevers and the flat panels adjacent to these walls reinforced to take the load due to water or earth pressure on the walls.

Filter design

The water from the recarbonation chambers is carried through concrete flumes the entire length of the filter gallery. The connections between these flumes and the filters are of cast iron pipe and are controlled by hydraulically operated valves. The filters are designed according to the usual practice, having cast iron laterals, 18 in. in depth of gravel and 27 in. of sand. The sand has an effective size of not less than .38 nor more than .45 millimeters with a uniformity coefficient of 1.65.

The filters are provided with a top wash system constructed of cast iron pipe and located at a level 2 in. above the normal elevation of the filter sand. The washing arrangement consists of 2-in. cast iron laterals on 30-in. centers, which are drilled on the horizontal diameter with $\frac{1}{8}$-in. holes on 6-in. centers. The purpose of this arrangement is to secure opposing jets and thereby scour the top layer of sand so as to keep it clean at all

Fig. 5. Designed for easy access and maintenance, the filter pipe gallery provides 7½ ft. of headroom and 8 ft. of clear width.

times and prevent accumulation of mud balls. The top wash system is designed for an effective maximum rise of 12 in.; the bottom wash is designed for a rise of 32 in. It is believed, however, that with the top wash system in operation, the rise of washwater coming from the filter laterals at the bottom will not need to be more than 20 to 24 in. All filters are equipped with concrete wash troughs.

The effluent from the filters in each wing is carried through a concrete flume below the pipe gallery floor to a common duct in the center of the building. In this duct there is constructed a concrete venturi flume which will permit automatic ammoniation and chlorination. There are two machines each for post ammoniation and post chlorination, located in rooms on the filter gallery floor. Directly below these rooms, space for the storage of chlorina and ammonia is provided. Dial scales, located in the storage rooms for weighing, are provided with extension connections so that the scale readings can be obtained on the filter gallery floor. The cylinders will be connected from the storage rooms to the chlorinators and ammoniators.

The total storage provided for filtered water is eight million gallons. This consists of a clear well at the filter plant of four million gallons capacity, and two equalizing reservoirs in the city, one of three million gallons capacity and the other of one million gallons capacity.

Piping and valves

All piping in the pipe gallery, with the exception of the pressure lines for hydraulically operated valves, is cast iron. Flanged pipe is used on all lines with the exception of the waste which is bell and spigot. The piping in the gallery has been so arranged that there is 7½ ft. clear headroom under the piping and about 8 ft. of clear width down the center of the gallery. This will permit easy access to all valves and piping for maintenance purposes.

All valves in this filter plant are hydraulically operated with the exception of the three raw water control valves previously mentioned. The pressure water for the hydraulically operated valves is maintained at 50 lb. by a pressure control and relief valve.

There are two instrument panels located near the entrance to the filter building, on which are mounted the indicating, recording and totalizing venturi meter registers showing: (1) the amount of raw water entering the plant; (2) the amount of washwater used; (3) the quantity of finished water passing through both the 24- and 30-in. mains to the city; and (4) the amount of water used for the top wash. A water level indicator is also included which shows the level in each of the equalizing reservoirs.

In addition to these instruments located on the instrument panels there are two illuminated washwater gages set at either end of the filter gallery. These show the rate of rise and the depth of washwater in the reservoir. There is also a clearwell recorder located near the central part of the building. In the chemical building there is a recording thermometer on the raw water supply.

The operating tables are constructed of domestic marble having a black marble top and gray marble base and ends; the access doors are of steel. On these tables are mounted loss-of-head and rate-of-flow gages and controls for the influent, effluent, waste, washwater and rewash valves. There are also pushbutton controls on the tables for the top wash pump.

The chemical and bacteriological laboratory is located on the second floor of the filter building. This laboratory consists of a main laboratory room and a smaller preparation room. Sample lines are provided to the laboratory from which the chemist can draw samples of the raw, settled and finished water.

Architectural features

The buildings of the purification works are of a modernistic style of architecture and constructed of a light buff brick with limestone trim. Large glass windows are used, particularly in the filter wings, in order to obtain as much light as possible, while over the filter gallery a clerestory is provided in order to light the central portion of the gallery.

In the central part of the building between the two filter wings, the intersection of the aisles of the filter gallery and the main corridor across the building are treated as intersecting barrel arches. This portion of the building is provided with a hung ceiling to a point 11 ft. above the floor. From this height to the floor the central portion of the building, or rotunda, is finished in Texas cor-

dova shell and cordova cream limestone. The upper part of this interior limestone forms a trough for the indirect lights used in illuminating this portion of the building. The rotunda is octagonal in shape and on the four corners are carved stone panels of about three-fourths life size, depicting the progress of the science of water purification.

In the center of the rotunda there is a marble fountain supplied with water from the clearwell. This fountain is so constructed that the water is entirely under glass with concealed lights below. The floor of the rotunda and filter galleries is terazzo in patterns formed with varying shades of green and gold. The interior of the filter galleries to a height of 11 in. above the floor is lined with a light sea green terra cotta. The interior of the chemical building is constructed of glazed brick tile. These buildings are designed with the idea of providing interior surfaces that can be readily cleaned at all times.

Cost and personnel

This project, costing $810,000, was financed with the aid of PWA which provided a 45 per cent grant; the city raised its share of the funds from the proceeds of the sale of water revenue bonds.

The work is now about 90 per cent complete and it is expected that a formal opening of the plant will be held sometime in the latter part of October.

The writer is consulting engineer on this work, and from his office J. Sanders Parker and H. H. Catching are serving as design engineer and resident engineer, respectively. The Charles H. Tompkins Co., Washington, D. C., is general contractor for the structures and E. W. Bacharach & Co., has the contract for installing the filter equipment and piping.

Pipe Coating Resistance To Soil Corrosion

Report of long-time field tests on metallic and other non-bituminous coatings for underground use

GENERAL conclusions drawn from tests conducted since 1922 on metallic and other non-bituminous coatings to determine their suitability for the protection of structures exposed to corrosive soils are reported by Kirk H. Logan and Scott P. Ewing in National Bureau of Standards Research Paper No. 982. Coatings investigated included lead, aluminum (calorized), zinc (galvanized), mill and foundry scale, and miscellaneous non-metallic coatings.

It was concluded that lead coating in general is not suitable for protecting steel pipes. Although in the early stages it reduces corrosion, after the lead coating is penetrated the rate of penetration of the steel is often accelerated, so that in many cases the pipe wall will be penetrated earlier on the lead-coated than on the bare steel pipe.

Seven soils tested

Specimens of pipe calorized by both the powder (dry) process and the dip (wet) were placed in seven soils in 1924. The powder-calorized coating was more effective in reducing pitting, although it allowed greater loss of weight than the dip-calorized coating. On the whole, calorizing made the pipe more resistant to soil corrosion, but did not prevent pitting in any soil. In most cases there was little difference between the rates of corrosion for ferrous pipe with and without mill scale. Of a group of non-metallic and non-bituminous coatings, vitreous enamel and hard rubber afforded the best protection over a 2-year period of exposure.

Galvanized metals

Tests of galvanized ferrous pipe and sheet were undertaken in order to determine the effectiveness of various thicknesses of this type of coating in withstanding soil action, and to ascertain whether or not one base metal was superior to another when the same weight of zinc was applied to each.

The galvanized iron prepared by the hot-dip process includes an outer layer of nearly pure zinc, a middle zone of one or more alloys of zinc and iron, and finally the metal to which the zinc was applied. The thickness of the alloy layer depends upon the methods used in galvanizing, and to some extent on the character of the base metal. It is not practicable to apply an exact amount of zinc or to apply the zinc as a perfectly uniform coating by the hot-dip process as used commercially.

For these reasons, and because of non-uniform soil conditions, some dispersion of the data for what is nominally the same weight of coating is expected. The determination of the effect of each factor in the corrosion of galvanized specimens under field conditions, therefore, would be practically impossible, even with a large number of specimens.

General conclusions

It was stated that only general conclusions may be drawn and these were as follows:

Over a 10-year period, the rates of loss of weight of galvanized steel were from one-half to one-fifth the rates for bare steel.

Galvanized steel corrodes most rapidly in poorly drained acid soils and in those containing a considerable amount of soluble salts.

For long periods of exposure, thick zinc coatings are superior to thin ones. A coating of 2.8 ounces per square foot of exposed surface prevented the formation of measurable pits in all but one soil for a period of ten years.

The type of ferrous metal to which the zinc is applied does not have an appreciable effect on the rate of corrosion of galvanized materials during the first ten years of exposure.

The rate of corrosion of galvanized steel is lower than that of either zinc or steel alone.

Experience with Wells in Fine Sand

by E. T. ARCHER
Consulting Engineer, Kansas City, Mo.

In ten years' service the capacity of Amarillo's well system has increased by virtue of continuous gravel-walling and recharge of groundwater by impounding

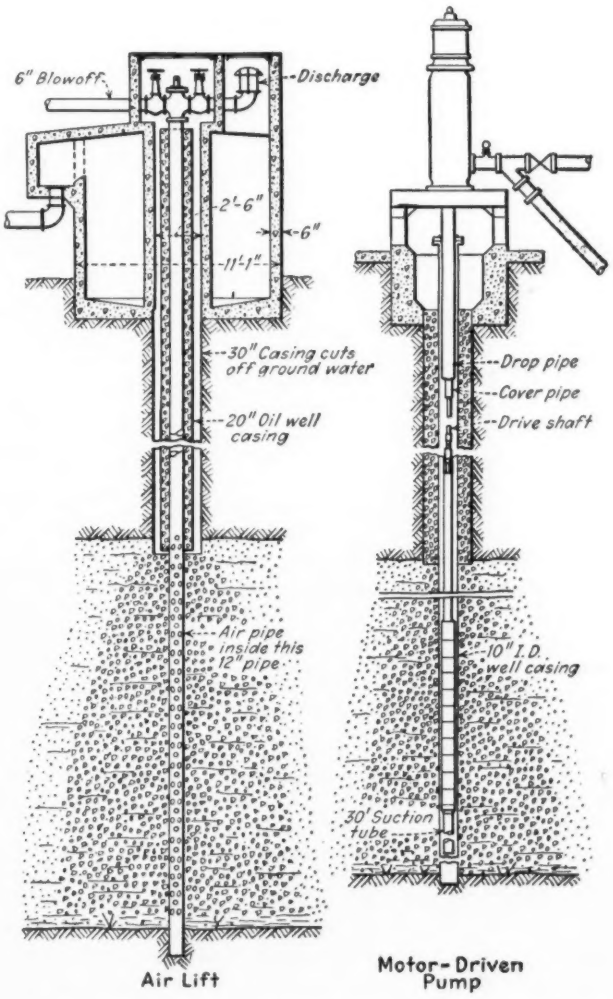
TEN YEARS' EXPERIENCE with the well system of Amarillo, Tex., shows that the problem of obtaining a continuous supply of water from fine sand and silt formations has been solved successfully. Ten years ago, I had occasion to go into this problem carefully with the late Wynkoop Kiersted, who at the time investigated its application to Amarillo and constructed a system of wells designed to overcome the difficulties of clogging to ultimate failure of supply. A present study of the conditions of this installation at the end of a ten-year period of operation should be of interest to city water officials as well as to all others concerned with the same problem.

Briefly, since 1927, when Amarillo completed its present groundwater supply, the system has not only given continuous service but has increased in capacity in proportion to enlarged demands, the population having increased from 25,000 to 50,000. No addition to the city's water-producing facilities has been made during this period.

The city is located in the semi-arid region; rainfall is so light that surface supplies and reservoir impounding are out of the question. Wells are the only dependable supply source. But until the present water supply was built the city continually faced a water shortage, as demand had outgrown the production of the existing wells and the yield of the underground strata in that section.

The present supply, lake-and-well system located 16½ miles from the city in the valley of the Palo Duro Canyon, consists of a series of ten wells constructed around an artificial lake. (See *ENR*, June 2, 1927, p. 904.) This location was chosen and the plant designed by Mr. Kiersted, who conducted a series of tests covering an area of several miles around the city.

The Palo Duro River rises near the New Mexican border and meanders across the state to a connection with the Red River near the Oklahoma line. Its lower course is marked by arroyos and deep canyons eroded to the Red Beds, while the upper course, filled with silt and sand from wind erosion, presents only a small depression below the natural level of the ground. It is on this upper section that the new supply was located. The tests showed a depth of 175 ft. to the Jurassic beds; the lower 80 ft. of this filled depth consists of exceedingly fine sand (passing 50 to 100 meshes per inch, averaging 80), which is overlain by sand, silt, clays and other eroded material. The



Wells at the Amarillo waterworks in which open screens are used. The fine sand drawn through the screens and ejected is gradually replaced by gravel introduced at the top of the casing.

lower stratum of fine sand is tapped by the ten wells, which are of gravel-wall construction.

In order to insure the permanency of this well supply a dam 42 ft. in height carried down to an impervious stratum was constructed across the Palo Duro Canyon, creating a reservoir of 500 acres. For the first four or five years no water was impounded in this reservoir, but thereafter water began to accumulate and at one time it rose to within 6 in. of the spillway. As the level of the impounded water falls after any use, large areas of the bottom and sides often are exposed, and under the intense heat of summer the drying silt cracks; when the water level again rises, water percolates through into the lower sands, replenishing the supply tapped by the wells.

It is this continuous accumulation of the flow of Palo Duro Canyon and adjacent territory, augmented by the storage in the artificial lake, that maintains the underground supply.

Open screens in wells

The wells proper are of unique design, a distinct departure from the standard practices of gravel-wall wells of that day, inasmuch as they reversed the accepted practice of holding out the fine sands by fine screens. Open screens are used, through which fine sand is drawn. As this sand is ejected from the well it is gradually replaced by gravel. The well is developed by a system of air injections which are followed by air-lift and backblowing operations. After all the fine sand has been removed centrifugal pumps are connected. This method of construction and development was perfected by P. S. Judy of the Air Made Well Co.

To develop these wells required introducing into each well ten carloads of screened gravel, ranging in size from ¼ to 1¼ in., and averaging ¾ in. After completion, the wells were backblown at frequent intervals. At the present time they are backblown every six months, each backblowing requiring half a yard of gravel to replace the fine sand extracted.

At the time of completion of the wells, tests to determine the outward movement of the gravel showed that in some instances it had traveled as much as 28 ft. from the well. There seemed to be no uniformity of the flow of the gravel in any one direction. In some instances the gravel went all in one direction, usually against the flow of the water.

Well capacity increased

When the wells were first put into service they gave a capacity of 160 g.p.m. This increased under the subsequent backblowing and replacement of fine sand and at present they will deliver 700 g.p.m. each. Eight of the wells continue to be operated by airlift; two have centrifugal pumps. The water passes through sand traps at the wells and is transported through gravity pipe lines to a small storage reservoir, whence two high-lift centrifugal pumps operated by 150-hp. motors force the water against 100-ft. head through a 30-in. pipe to a reservoir in the city.

The city's water supply demand at the time of completion of this project was 2½ m.g.d. At present the summer demand averages 6.4 m.g.d., with a maximum of 9 m.g.d. on July 27, 1937.

The plant is operated by electricity purchased from the local utility on the basis of 1.81c. per kwh. For an average of five months during the past year the cost per 1,000 gal. was as follows: Production, 1.626c.; transmission, 1.969c.; distribution, 1.030c.; total, 3.625c. Consumer rates ranging from a maximum of 27c. per 1,000 gal. down to 12c. produce ample revenue to operate, maintain and finance the water department.

Some four years after starting operation of the system and before any water had accumulated in the surface reservoir, the city officials became fearful that the supply might decrease as it had done in their earlier wells. They therefore developed a water supply 2½ miles from the city by building five wells of ordinary type and equipping them with turbine pumps. These five wells gave an initial capacity of 5 m.g.d., receded quite rapidly, and at the end of four or five months gave out entirely. By allowing them to stand idle for several months the operation could be repeated, but the initial capacity of the wells was less at each operation and at the present time the maximum starting quantity is only one-half of what it was at the beginning and operation can continue only about two months. The cost of the operation has increased until it exceeds the cost of operation of the supply at Palo Duro, indicating that the sands have packed around the screens and have cut the runners of the turbines.

The outstanding engineering feature of the Palo Duro supply is the fact that at the end of a period of ten years of operation the supply is greater than at the beginning, demonstrating that it is possible here to extract a million gallons per day per well from a stratum of 80 ft. of exceedingly fine sand. The negative experience with the wells nearer the city would indicate that these results can be secured only from a well development in which the fine sands are continuously extracted and replaced with gravel during the operation.

Acknowledgment

The plant is managed and maintained by H. R. Smith, city manager, to whom the writer is indebted for many courtesies extended in the collection of the data required for this article. Appreciation is also expressed to A. B. Moss of the Water Department, Jack Wyatt, city chemist, and Ross D. Rogers, mayor.

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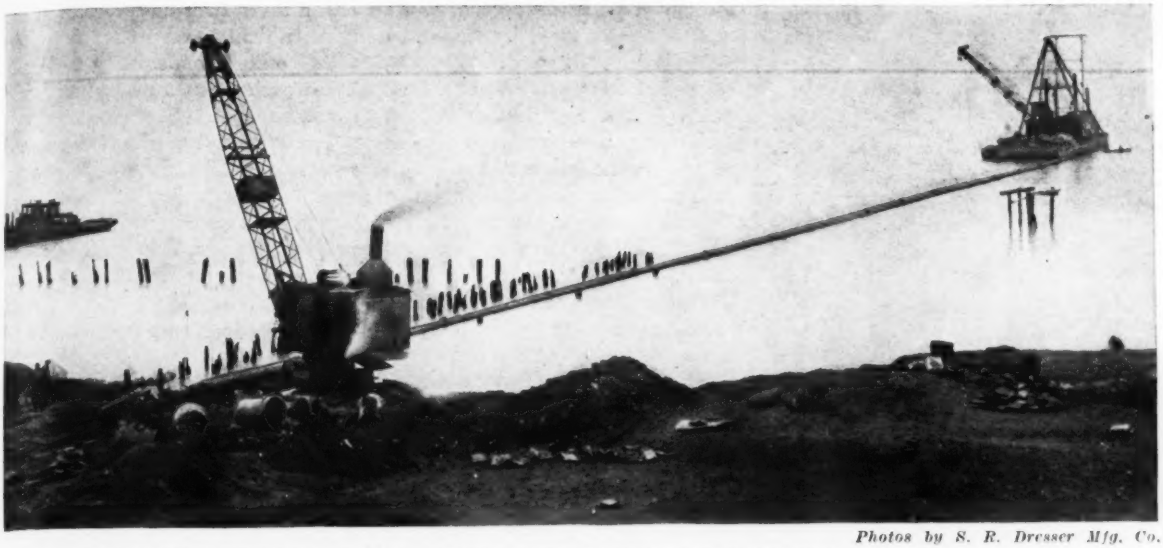
Fluorine at Topeka Reduced by Treatment

SOUTHWEST water supplies in many places contain fluorine, but Topeka, Kan. has no worries on this score. According to Daniel W. Rupp, water production engineer, who has been making fluorine tests on 10-day composites for years, the Topeka supply does not contain enough of this chemical to cause mottled teeth in children. The water softening treatment consistently removes more than one-third of that found in the raw water. The maximum in the untreated water since 1935 has been 1.2 p.p.m. and the minimum 0.07. The average in 1935 was 0.48 reduced to 0.36 p.p.m.; in 1936 the reduction was from 0.72 to 0.40 p.p.m., and for 4 months this year the reduction was from 0.95 to 0.55 p.p.m. Up to 2 p.p.m. is generally not considered troublesome.



Photos by S. R. Dresser Mfg. Co.

FIG. I. STEEL PIPE LINE OF 20 IN. DIAMETER BEING FLOATED INTO POSITION BEFORE SUBMERGENCE.

Floating a Water Intake Into Place

Pipe sections joined with flexible couplings on lake shore are floated into position and then sunk by releasing entrapped air

WATER intake lines of 12- and 20-in. steel pipe, carried offshore into Lake Erie for more than 600 ft., were quickly and economically placed by joining sections of pipe on land and floating them into position. This installation was made possible by the use of flexible bolted harness couplings, and by capping the offshore end of pipe so that air was entrapped to provide buoyancy. Pipe laying operations were completed in one day, after the pipe had been coupled in 120-ft. sections.

The intake lines were installed to furnish water to the Union Salt Company Plant in Cleveland, and replaced an intake conduit opposite E. 65th St. that was covered by the city as the result of land reclamation activity along the lakefront. Because of filling operations, a considerable amount of material was washed into the old intake.

The steel pipe, ¼-in. thick and spiral welded, as purchased in 40-ft. lengths and coupled on shore in 120-ft. sections. The sections were then stacked on top of each other in a shallow trench at the water's edge. From this position they could be easily pulled into the water. The 12-in. line was 814 ft. overall with about 640 ft. under water. The 20-in. line was 814 ft. overall with about 640 ft. of this length under water.

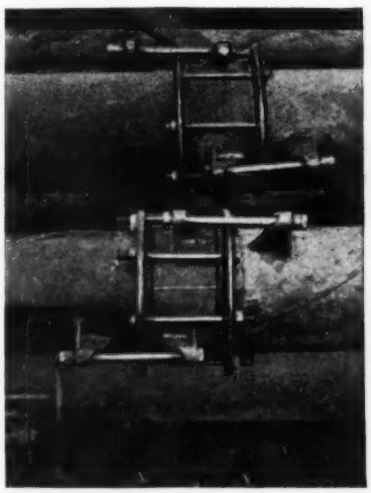


Fig. 2. Flexible couplings with harness bolts used in the assembly of 40 ft. pipe lengths.

The couplings used for joining the pipe were standard make of flexible pipe joints, of sleeve-type construction. In this joint, the pipe ends are "stabbed" into a center ring, flared at each end. Against and under these flares, wedge-shaped rubber gaskets are fitted. Follower rings behind each gasket, connected with bolts, exert pressure against the gaskets when the bolts are drawn up. This in turn causes the gaskets to compress tightly around the pipe, affording a flexible, water-tight connection.

As shown in Fig. 2, harness bolts were used on these intake lines as auxiliary equipment to lock securely together adjoining pipe sections against the severe weaving action of the waves, as well as lowering stresses and movements after installation. There are four bolts to each coupling, located equi-distant around the circumference and they are alternately attached to adjoining pipe sections. To preserve the flexibility of the coupling the harness bolts are secured with about one inch "play."

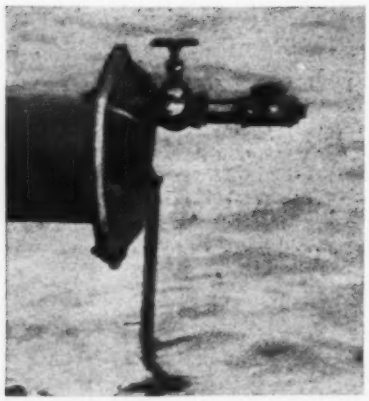


Fig. 3. Flange cap, fitted with a 2 in. valve and nipple, secured to the offshore end for admitting water.

The pipe laying operations were handled with the aid of a floating crane and a crawler crane on the shore. The position of the former was governed by two cables attached in "V" fashion from crane to shore, which were paid out as required. Wood piles, driven in the lake along the line selected for the location of the intake, were used to guide the pipe as it was towed into position.

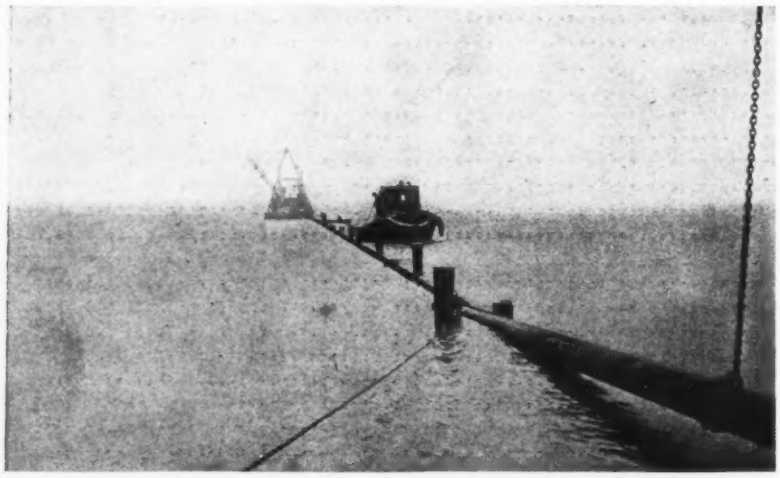


Fig. 4. Opening the valve on the offshore end permitted water to enter slowly and gradually sink the pipe. The shore end was held up above water until the air was displaced.

Actual start of the work was delayed several days awaiting a calm lake and an off-shore wind, so as to simplify construction work and make unnecessary precautions against the pipe or floating crane being forced back toward shore.

Operations were started by attaching the end of the first section of pipe to a cable on the floating crane, which moved out into the lake and thus pulled the pipe forward. When the shore end of this section had reached a point just a few feet from the water's edge, the second section of pipe was connected and the entire assembly was again moved another 120 ft. This procedure was continued until all sections were moved into position.

The pipe line was made buoyant by sealing the outer end of the first sections with a flanged cap before the pipe was pulled into the lake. A two-inch globe valve inserted in this cap provided a means of permitting water to enter the line when the time arrived for sinking it. The pipe line, filled with air, floated on the lake surface about two-thirds submerged. While it was impossible to determine if any leakage occurred, the fact that the pipe did not lose its buoyancy makes it almost certain that the line was tight throughout.

The shore end of the final length of pipe was held up above the surface of the lake so that no water could enter. When the entire intake was in position, water was admitted through the valve on the offshore first to prevent air from being trapped in the pipe. As the line filled with water, it gradually settled into a shallow trench previously excavated on the like bottom. The pipe was sunk to a depth of about 17 ft.

A row of piles was driven on the side opposite that of the guide piles and a diver then nailed cross pieces between the two rows of piles to keep the pipe line from shifting vertically. The trench was then back-filled with sand.

The land end of the intake terminated about 15 ft. from the shore and here the final connection was made to the land section which had been made previously. This work was done under water by a diver.

Direction and personnel

The intake lines were installed for the Union Salt Co. by the city of Cleveland, division of engineering, of which Robert Hoffman is chief engineer. Design and construction were under the direction of Burks Oakley, engineer in charge of lakefront development, and Arthur E. Stevens, assistant engineer. General contractor on the job was the American Construction Co. of Cleveland.

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Singapore Water Losses Held to Low Figure

ACCOUNTING for 95.1 per cent of the water delivered into the distribution system during the year 1936, the Singapore municipal waterworks believes that this may be a world record. The average daily consumption at this place was 17,000,000 gal., 93.5 per cent of which is metered and 1.6 per cent estimated.

In the annual report of the department, D. J. Murnane, engineer, states that this figure for the year is actually 3.6 per cent more than 1935, and the best ever recorded in the history of the department. The water was metered by venturi meters where it passed into the distribution system from two purification plants; at one of these plants the Venturi meter checks the slip on triple-ram pumps, and the figures regarding slip are good. Of the total amount of water so supplied to the distribution system, 93.5 per cent was registered on consumers' meters; 1.6 per cent is estimated to have been used by the fire brigade and in flushing mains, etc.

Assuming that 3 per cent of the balance was under registration of consumers' meters, said Mr. Murnane, the remainder represents a leakage of less than 80 gal. per inch mile per day on the distribution system.

Photos Bur. of Plant Entomology and Quarantine

FIG. I. SPRAYING IS AN EFFECTIVE CONTROL MEASURE FOR MOUNTAIN MEADOWS THAT CANNOT BE DRAINED.

Mosquito Control in the Mountains

by H. H. STAGE

Associate Entomologist, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Portland, Oregon

Vicious pests which hatch in melting snow pools are combatted with larvicide spray, drainage ditches and water level manipulation

Mosquito control activities, in which engineers play an important part, are widespread in this country. Various regions have their special problems because of the different species and habits of this pest. Principal measures of control are improvement of natural drainage, regulation of water levels, and application of oil or lethal sprays. This article describes the technique used in mountain areas. For a complete discussion of other mosquito control methods see ENR, July 23; Aug. 6, 13, 20, 27; Sept. 3, 10, 17; 1936. —EDITOR

THE MOSQUITOES which are commonly referred to as "mountain mosquitoes" or "snow mosquitoes," occurring at high altitudes and in northern latitudes, belong to the genus *Aedes*. Unlike other species, they lay their eggs on the ground, produce only one brood a year which hatch early in spring soon after the snow begins to melt, and occur in great numbers. They persist in myriads for several weeks, dealing misery to man and beast over beautiful recreational areas in the high mountains of the United States, the prairie and lake country of Canada, and the mountain and tundra country in Alaska. Young caribou, colts, and calves have been killed by their attacks and many a vacation and fishing trip has been ruined by their unwelcome presence.

It is hard to understand why man has tolerated such tormentors so long without doing much about it, but areas where control of these insects has been attempted are exceedingly few. Perhaps their active season of two or three months is thought to be too short, or their range of activity too limited to be considered seriously, or it may not be widely known that these species often can be controlled at moderate cost. Be that as it may, in these times when more and more of our people are seeking the pleasures of out-of-doors recreation, it is opportune to discuss the problems and possibilities of mosquito control in mountainous districts which have been dedicated to public use.

Since the mountain species of mosquitoes have the peculiar habit of laying their eggs directly on ground which, in season, is normally covered by snow water or spring freshets, the habitat aspects of control are comparatively simple. In the fact that there is but one brood each year we find a great difference indicated between these species and the salt-marsh, artificial-container, and malaria types of mosquitoes, all of which produce several broods annually. However, the inaccessibility of the breeding areas and the great

numbers of wrigglers produced more than tax the ingenuity of the engineer who attempts their control.

Minor differences of habit are, of course, to be found among the several species of *Aedes* mentioned: *A. fitchii*, *A. hexodontus*, and *A. aboriginis* are found together in shallow, grassy pools or even in small holes made by the hoofprints of horses and cattle; *A. communis* is found at the higher elevations along the margins of the larger and more open meadows; and *A. ventrovittis*, a vicious biter, is found at very high elevations in small pools of snow water. On some mountain areas, wrigglers of all stages may be found over a period of two or three months, giving the layman the impression that more than one brood is developing.

The explanation is that some of the species develop much more slowly than others, and some in much colder water than others. *A. intrudens* passes the larval stage in water near the freezing point, develops at a rapid rate compared with *A. hexodontus*, *A. prionips*, and *A. pullatus*, and is on the wing long before the latter species. Some species show a decided tendency to migrate downward from high elevations, while others travel mostly upward. All of these facts must be borne in mind in efforts to protect a mountain hotel or recreational center. These differences in habit serve to illustrate the importance of collecting adults and having them identified by experts in order that the breeding areas may be accurately determined.

One broad principle of mosquito control applicable to these species is the necessity of carefully inspecting every bit of water or swampy ground to locate wrigglers. When found they should be killed by spraying about 20 gal. of a light fuel oil per acre of water surface. (Fig. 1.) As with the species more frequently controlled, it is necessary to apply the oil by means of a fine spray rather than in a stream, and to make sure that the water surface is completely covered with an oil film. The use of pyrethrum larvicide at the rate of about 50 gal. per acre is perhaps more desirable than spraying with oil because it is not injurious to aquatic vegetation or animal life.

Pyrethrum larvicide (*ENR*, Aug. 13, 1936, p. 228), is made up to contain 66 per cent of kerosene or a similar light petroleum oil containing pyrethrum extract (equivalent to 1 pound of pyrethrum flowers to the gallon of oil) and 34 per cent of water containing from 3 to 5 per cent of soft soap. The ingredients are mixed by violent agitation, thus forming an emulsion which mixes readily with water. For use in killing mosquito larvae and pupae, this stock solution is diluted with from 10 to 15 times its bulk of water and sprayed on the mosquito-breeding pools. Because a considerable amount of treating may be necessary before the snow has melted sufficiently to permit transportation of drums of oil or larvicide to the breeding areas, it is desirable that materials for this purpose be stored on the ground

More permanent control of mountain or snow mosquitoes can be effected by another method, which hinges on the fact that the breeding grounds of these mosquitoes are flooded only for a few weeks in the spring and dry up completely after early summer. If an area either remains dry or remains flooded throughout the season, these species can not exist on it. Bodies of water, whether large or small, that naturally have permanent water levels can therefore be ignored in efforts to control these pests. Also, bodies of water that have heretofore served as a habitat for these pests can be prevented from doing so in the future by artificially maintaining them at a permanent level. Measures for the latter purpose, incidentally, aid in the propagation of wild life.

Surrounding many mountain ponds and lakes are meadows of varying sizes, but slightly higher in elevation than the ponds. Early in the spring these meadows are flooded to a depth of several inches with ice-cold water, which drains from the surrounding banks of snow. (Fig. 2.) Upon inspection, this water is often found to be teeming with mosquito larvae, and, on many inaccessible areas, adults may emerge from it even before roads and trails have been cleared of snow.

Considerable remedial work of a semi-permanent nature can sometimes be done in either of two ways: (1), the level of the lake may be maintained by providing an adequate outlet to carry off surplus water

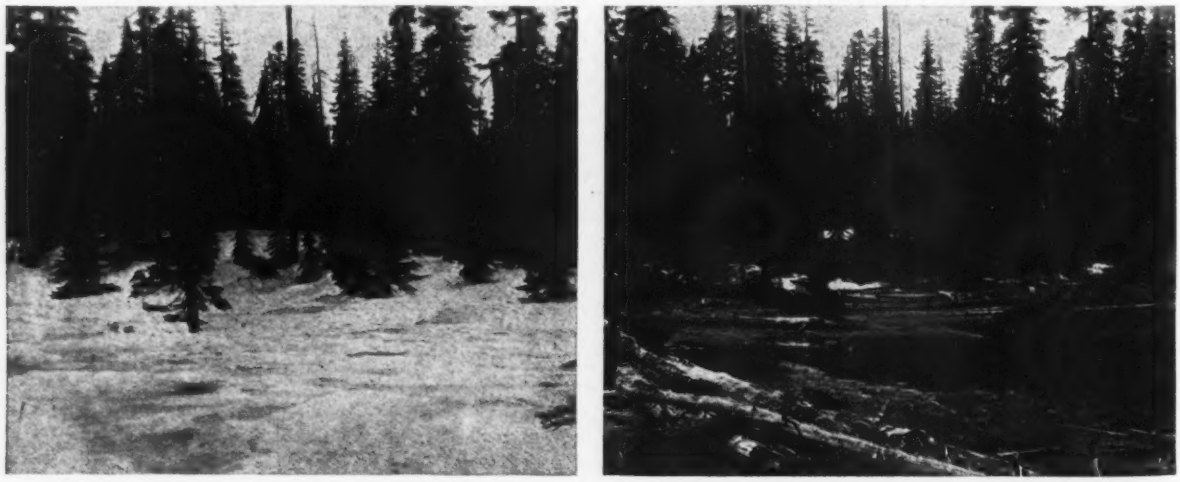

Fig. 2. Mosquitoes hatch in the melting snow which forms pools of water. The two views of the same spot were taken six weeks apart, during which time myriads of pests emerged.

Fig. 3. Drainage system consisting of seepage ditches at the bases of hills and laterals to the lakes minimized breeding opportunities in this area. Dynamite was used to blast the ditches.

which rises above the normal margins of the lake in spring; and (2), small dams can be constructed across the outlets of ponds and lakes which will hold the water level constantly high and so prevent the deposition of eggs along the upper margins.

Along the upper margins of these meadows, also, is found water which has seeped from higher elevations. A considerable amount of such water may be present early in the spring, but may remain only a few weeks. Such a condition is ideal for the breeding of the mosquito species under discussion. Satisfactory control can be effected under such conditions by constructing ditches parallel to the contours at the upper margins to collect the seepage, and secondary ditches to transport it to the main channels of streams, or to ponds. Mosquitoes may later oviposit at the upper margins, but the eggs cannot hatch since all free water quickly flows off.

Water level manipulation

A good example of controlling mountain mosquitoes by manipulating water levels is shown in Fig. 3. Two lakes, appropriately named Big and Little Mosquito, located near Mosquito Guard Station in the Columbia National Forest, Washington, have been notorious in the past for the huge swarms of mosquitoes present from the melting of snow in spring until late in the summer.

In spring most of the open meadow was covered by snow and seep water, and the larvae of *Aedes aboriginis* and *Aedes hexodontus* were plentiful throughout that portion. The levels of the lakes were high in spring and low in summer. Seepage water from the forested hills surrounded the meadows. This seepage, since it could not run off or percolate into the already saturated soil, remained until dried up by the sun. Ideal conditions were thus provided for oviposition by *Aedes* mosquitoes.

The Forest Service decided to correct this condition by means of dynamite-blasted ditches (Fig. 3), to drain the several springs in the meadows. Since the small lake shown in the foreground was somewhat higher than the large lake, a ditch 800 ft. long was blasted between them. This lowered the water level in the smaller lake by 18 in., following which this lake accommodated accumulations of spring water emanating from the upper meadows. Seepage water was drawn into the large drains by smaller ditches which follow the contours at the bases of the hills. The meadow surrounding Big Mosquito Lake was subsequently flooded permanently by constructing a dam 6 ft. high and 40 ft. long across Mosquito Creek.

Approximately 10,781 lin. ft. of ditches, involving 2,342 cu. yd. of soil, was blown out by means of dynamite. This required 942 man-hr. of labor and 4,350 lb. of 50 per cent special ditching powder. This work was done in July and August. Because the soil was somewhat dry, it required greater than normal amounts of labor and dynamite.

At the end of the second breeding season, as a result of raising the water level in the large lake by ditching, less than 30 gal. of oil was necessary to effect perfect control. The benefits have been considerable; available pasture has bees increased 25 acres; pot-holes, a hazard to stock, have been eliminated; the area of the large lake has been increased two or three times in size, which increases its capacity for trout and wild fowl; the amount of early spring runoff has been considerably reduced; and mosquito breeding has been successfully controlled over approximately 600 acres.

Manipulation of water levels thus offers a substantial aid to mosquito control and wild-life propogation in many mountainous districts. In addition, it contributes to flood control and soil conservation.

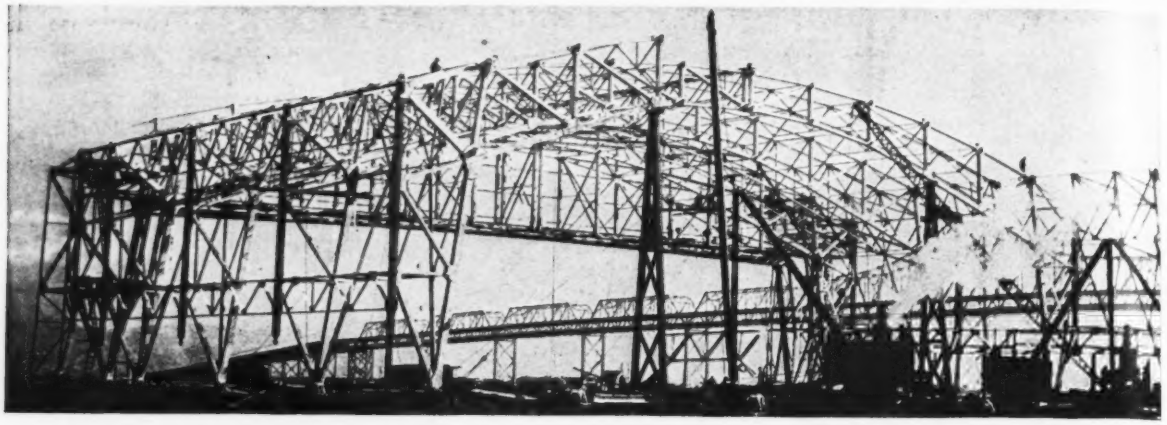

FIG. I. STEEL FRAMEWORK FOR THE FIRST HANGAR AGAINST A BAY BRIDGE BACKGROUND.

Concrete Walls as Counterweights

In exposition buildings at San Francisco, designed for later use as hangars, arch dead loads are counterbalanced by hanging walls from the steelwork

TWO AIRPLANE HANGARS recently built at San Francisco utilize three-hinged arches for the structural steel frames so designed as to carry each concrete side wall as a cantilevered load hung in a vertical plane outside the arch pin lines. The structures will be used first by the Golden Gate International Exposition; later, when the fair is over and the site is converted into a municipal airport, these two buildings will be adapted to their permanent function as hangars. Except for an administration building all other structures now being erected on the 400-acre island recently formed by dredging operations in San Francisco Bay, are temporary and will be removed at the close of the fair. The two hangars, which are duplicates in size and appearance, make ideal exposition palaces by reason of their large floor plan free from columns and a clear height of 65 ft. under the center arch pin.

Because all concentrated loads on the island have to be supported on piles, and because no interior columns were permissible in the hangars, an economical design was worked out in which pile clusters support the foundation for a steel superstructure consisting essentially of arched trusses with a span of 217 ft. Suspending the outer walls on a portion of each arched truss, extended for this purpose outside the pin line, counterbalanced most of the dead load in the trusses, decreased the stresses in the center portion of the arches as well as in the arch ties below floor level, and effected a considerable saving in the cost of the structure. This design involved a number of unusual features which are described in the following.

Suspended wall design

Each hangar has overall plan dimensions of 265x335 ft.; the superstructure is supported on 10 steel arches whose top and bottom chords have radii of 360 and 184½ ft., respectively. Wind stresses are taken into these chords by horizontal trusses, and *X*-type bracing and then are transmitted to the arch pins by vertical scissor-leg trusses in alternate bays.

Typical arches are spaced on 41-ft. centers; the two at either end of the building are 17 ft. 2 in. apart to provide support for massive concrete pylons at the four corners. These pylons are for architectural effect and will house the sliding doors to be added when the structure is made over into a hangar. Doors will consist

Fig. 2. Concrete footings for the 3-hinged arches are supported on piles. In upper right note longitudinal trusses from which lower portions of the suspended wall will be hung.

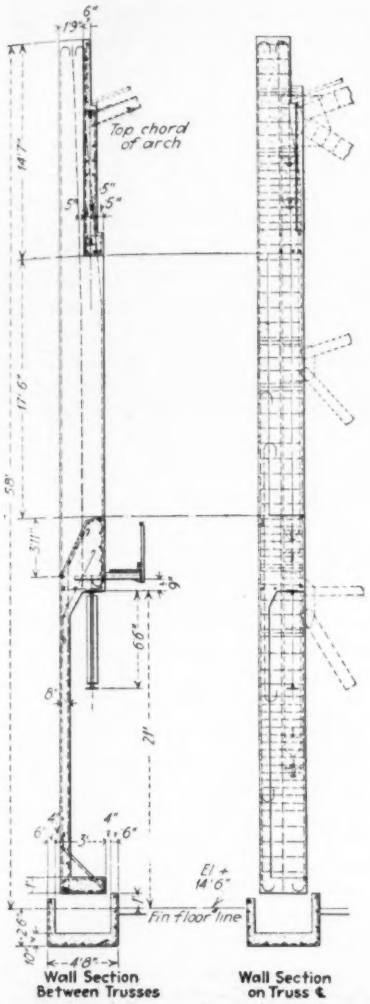

Fig. 3. Details of the suspended wall.

of 14 manually operated leaves each 14 ft. 7½ in. wide by 42 ft. high, fabricated from 8-in ship channel sections and operating on rollers at top and bottom. Support for the doors is provided by a line of piling under the door track, but wind load will be carried into the arches by horizontal trusses between the two end arches. During the Exposition the door openings will be closed by temporary plaster construction. The concrete walls in the pylons, and also the side walls of the building, are 8-in. thick and are suspended, as were the forms during pouring, from the steel superstructure. In each pylon the weight of concrete which is hung from the structural steel arches is approximately 330 tons.

Considerable savings in arches and in foundations were effected by use of the cantilever principle in supporting the walls. The lower pin of each arch rests on a welded steel base bolted to a concrete pier supported by 18 piles. Each concrete wall, weighing about 190 tons per bay, (41 ft.) is hung on a lever arm of 9 ft. 4 in. outside the lower pin line. This results in very small bending stresses in the central portion of the arch and gives a net horizontal thrust of about 20,000 lb. as compared to the 75,000 lb. thrust if no cantilever walls were used. Thus ties between foundations under the two side walls were provided chiefly to increase the resistance of the structure to earthquake shocks. The seismic factor of 0.08 *g.* was used throughout the design of the hangars.

Piles driven to batter

As a means of decreasing stress in the ties the piles were driven at a batter to conform with the dead load resultant from the steel arches. The outside rows of piles were given additional batter to increase the bearing area of the piles where the load is transferred to the ground. The ties are 18x24 in. reinforced concrete beams placed below floor level and supported at 36-ft. intervals by single wooden pile. Ties will be protected from any floor loads by supporting the floor slab on concrete walls placed either side and extending above the tops of the ties. During the exposition a temporary timber flooring will be used; the permanent concrete floor will be poured after there has been this additional time to allow for settlement of the fill which is being created for the fair site.

Wall construction

The structural steel framing consisting of arch trusses and longitudinal bracing was erected in its entirety before beginning to pour the walls or to construct the roof. In this way the rate of constrction in walls and roof and hence the total dead load could be coordinated so that at no time would there be unbalanced loads that might cause stresses in excess of those specified.

The side walls are of reinforced concrete 8 in. thick and have a double curtain of reinforcing consisting of ½-in. steel rounds at 12-in. centers each way in each face. Side walls were figured for a wind pressure of 15 lb. up to a height of 60 ft. and above that at the rate of 20 lb. per sq. ft. The roof, which was figured for a loading of 15 lb. per sq. ft. consists of 3-in. T & G planks on which was placed the composition weather surface.

The side walls are attached to and supported by the outer vertical members of the steel arch trusses supplemented by longitudinal trusses in the plane of the side walls. Stiffening is provided by beam or truss in other than vertical planes. The lowest of these is a reinforced concrete beam in a horizontal plane as shown in Fig. 2; there are two others, both of structural steel, one in the roof plane and the other in a horizontal plane just below the level of the side windows. These stiffening members all have a

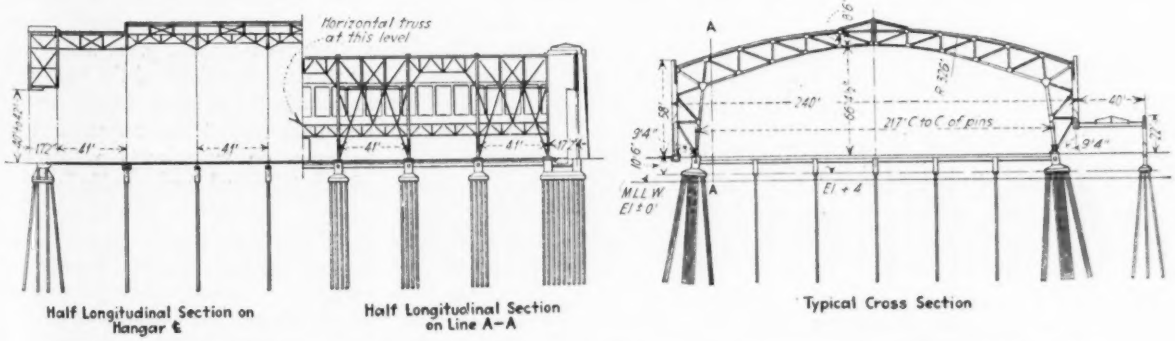
Horizontal truss at this level
Half Longitudinal Section on Hangar ℄
Half Longitudinal Section on Line A–A
Typical Cross Section

Fig. 4. Longitudinal and cross sections of the airplane hangar frame, showing directions of driving piles.

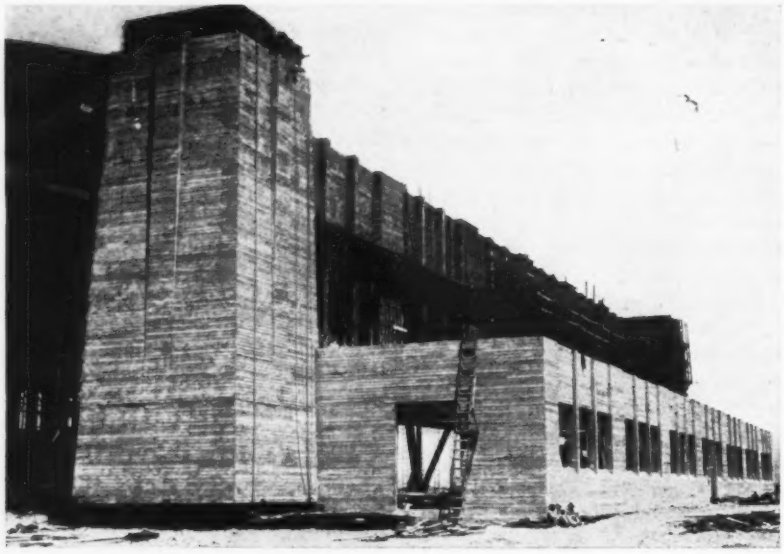

Fig. 5. Pylons at either end of the side walls, giving a massive appearance to the structure, are also suspended from the structural frame.

41-ft. span and their functions include the delivery of wind load and other horizontal stresses into the steel arches. The truss in the roof plane uses some of the 10-in. rafters as part of its truss system. The longitudinal bracing system delivers stresses to the arch pins through bifurcated members designed to take the end thrust.

A wall suspended on a cantilevered support requires provision for possible movement at the wall base. Hence a reinforced concrete trough was put in large enough to receive the lower edge of the side wall and its horizontal stiffening beam. A sliding copper sheet maintains a tight joint between wall and trough. The unfinished grading of the site when the building was erected made it necessary to construct this trough somewhat deeper than would have been necessary otherwise. However, the top of the trough is at an elevation about 12 in. above the finished floor level of the hangar, thus the joint in which there may be small movement between fixed foundation members and the side wall does not occur at floor level. Details of the side wall are shown in Fig. 4.

On the south side of the hangars a machine shop 40 ft. wide extends for the 300-ft. length of each hangar. Somewhat unusual design was required in the roof of this shop because only one edge of the roof was supported directly upon the foundation. The opposite edge, that is, along the wall of the hangar proper, was connected to the suspended side wall where vertical movement is expected.

The 40-ft. span across the shop roof is made by 24x9 in., 80-lb. steel beams on 20½-ft. centers. Along the hangar walls these steel beams are attached to the arch members and to the trusses between the arches by a single connection at the center of the 24-in. beam web. This connection consists of two angles fastened by three rivets close together. Thus the connection comes as near as practicable to the theoretically desirable pin of a hinged joint. It is expected that the maximum movement at this connection will come during loadings incidental to construction, hence there should be no difficulties in later maintaining a tight joint. There will be sufficient flexibility in the 40-ft. length of the steel beams to permit deflection of the main arches due to wind loads and temperature changes.

To take care of movement, resulting from arch deflection, in the 4½-in. reinforced concrete roof slab over the shop, vertical joints filled with mastic were put in the roof. These joints run parallel to the side wall and reinforcing steel of the roof slab is not continuous through them.

Quite another type of joint of somewhat unusual nature was required in the 2-in. reinforced shotcrete coating used on the ends of the hangar above the door openings. This shotcrete and the wire fabric supporting it weighs as much as 1,800 lb. per running ft. at the center and this loading was expected to cause corresponding deflection in the end truss. Consequently, a *V*-joint in the center of the shotcrete surface was planned. That is, before the shotcrete was started a vertical joint was made in the middle of the end panel separating the two halves; the joint was 3½ in. wide at the top and the width decreased to zero at the bottom. This allowance proved to be about right: when shotcrete application had been completed deflection of the arch had changed the shape of the *V* to parallel lines.

The hangar door openings are 200 ft. wide and the plan is to have the height vary from 40 ft. at the sides to 42 ft. at the center. For architectural reasons the upper line of the doorway is an arc inscribed on 2,500-ft. radius. With a view to the possible requirements of a higher door opening should larger airplanes come into use, the entire ends of the building are designed for convenient removal. It will then be possible to utilize an opening with a central height of 65 ft.

Design of the two hangars was worked out by the Division of Structural Engineering, Golden Gate International Exposition, John J. Gould, chief structural engineer. The late Geo. W. Kelham was chairman of the architectural commission. William P. Day is vice-president and director of works, and Harry C. Vensano is chief of construction. Contract for construction of the hangars was held by McDonald & Kahn; structural steel was furnished and erected by the Judson Pacific Company.

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Building "Boosters" For the Water System

FUTURE CITIZENS of Wilmette, Ill. will be good boosters for the water system if early contact and study mean anything. As part of self-expression in art, grade school pupils visited the filtration plant and made large scale drawings of the part that had made the greatest impression on them. Arranged in sequence and mounted on large reels a "motion picture" record was made which, when the crank was turned, revealed in turn each student's handiwork. As the reel unwinds the child whose picture shows explains his quota of facts. W. M. Olson, superintendent of the water department, helped the children to understand the plant's workings.

Underpinning a Busy Railroad Viaduct

Sewer tunnel under high approach to Detroit Union Terminal requires picking up structure on H-beam piles for both temporary and permanent support

AN INTERESTING JOB of underpinning the high, busy viaduct approach to the Detroit Union Terminal was required to protect the structure against possible settlement from driving Section 8 of the city's new intercepting sewer. For more than 2,200 ft. the sewer, a 19-ft. tunnel in soft blue clay, passes under the center of the viaduct with a cover of only 16 to 20 ft. Within this distance are 70 two-post bents of fabricated steel columns, resting on shallow spread concrete footings and carrying three railroad tracks in constant use.

In general the bent posts are 40 ft. apart, and the bents are spaced 35 ft.; every second and third set of columns is framed as a tower with longitudinal braces. The tracks are about 25 ft. above ground level. At one point the bent framing and spacing departs from uniform to clear a freight line crossing on the ground. At another point, special underground work is required around the Michigan Central Railroad tunnel, which crosses the viaduct line just below the sewer tunnel level.

General underpinning scheme

In brief, the scheme of underpinning is to drive from four to eight steel H-beam piles to hardpan at a depth of about 100 ft. and outside the old footings, then build up a steel grillage on these piles to catch a pair of bracket beams bolted to the sides of the column. The column is lifted free of the old footings by hydraulic jacks and shims. After the old foundations have been removed, 100-ft. steel beam piles are driven as permanent foundation supports, capped with a new concrete pedestal and the column load is then transferred to the new foundation. In all cases the temporary support piles fall within the new foundation lines and are cut off at top of footings to become part of the permanent structure.

The above is the general scheme, but there is a variation in details of underpinning, depending upon column load, position and other conditions. In fact, of the 70 bents affected, eight complete bents require no underpinning, as the effective line of disturbance, as determined by the method shown in Fig. 3 (upper right), falls above the old footing level, four columns similarly require no treatment, three bents will be removed and reframed, and four more single columns will be taken out. This leaves 117 columns to be underpinned.

Specifications require that all temporary and foundation piles be driven with the web normal to axis of the viaduct. The old columns are of four fabricated types, some of which permit bolting of the pick-up beams parallel to the track; others must be fastened normal to the track. This feature alone requires two general types of cribbing (Fig. 2).

The first step is to drive from four to six temporary support piles in

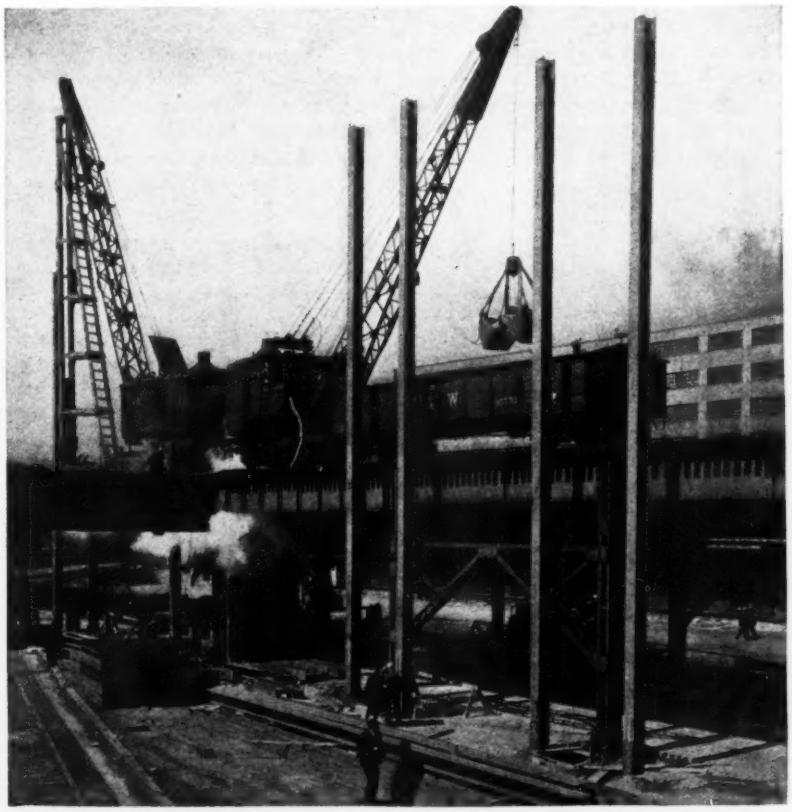

Fig. 1. Spliced H-beams 100 ft. long are driven as pile underpinning for columns of the Detroit Terminal railroad viaduct. A big soft-ground sewer tunnel under the viaduct necessitates the underpinning work.

Fig. 2. Details of a typical underpinning assembly, one of several types required by various column loadings. After the temporary support piles have served their purpose they are incorporated into the permanent foundation system.

two rows. These, as are also the foundation piles, are 14-in. 89-lb. H-sections. They are all about 100 ft. long, spliced as necessary to reach hardpan in two 40-ft. and one 20-ft. lengths by field-welded straps on the web and inside flanges. The support piles are driven close to desired grade, and are then capped by two short channels, back to back against the web, welded in place to exact predetermined elevation. Over the tops of these channel clips are placed 10-in. to 24-in. distributing beams, clamped to the supporting piles by bolts, straps and clevises. The grillage built above the distributing beam depends upon the type of column pickup which is used in each case.

The column brackets are channel sections bolted with their back to the sides of the column. Size varies from 12 to 18 in. and they average 6 ft. long. Steel billets and shims are placed directly under the column brackets. Many of the pickup members are reinforced at point of loading with short vertical lengths of angles welded to the web.

Permanent foundations

After the columns have been jacked free, the old footings are torn out, usually within sheeted pits. The foundation piles, four to twelve in number, are then driven to hardpan. To effect a better bond with a new foundation concrete, two short sections of ship channels are welded as clips to the web of each pile. The clips clear the bottom of footings by 4 in. The piles are driven to predetermined grade, so no cutting off of the top is necessary, except on the temporary support piles that fall within the new footings, which are cut off at top of footing base section as shown in Fig. 3.

The base of the new foundations are built at the same elevation as the old base. The foundations consist of a rectangular reinforced base

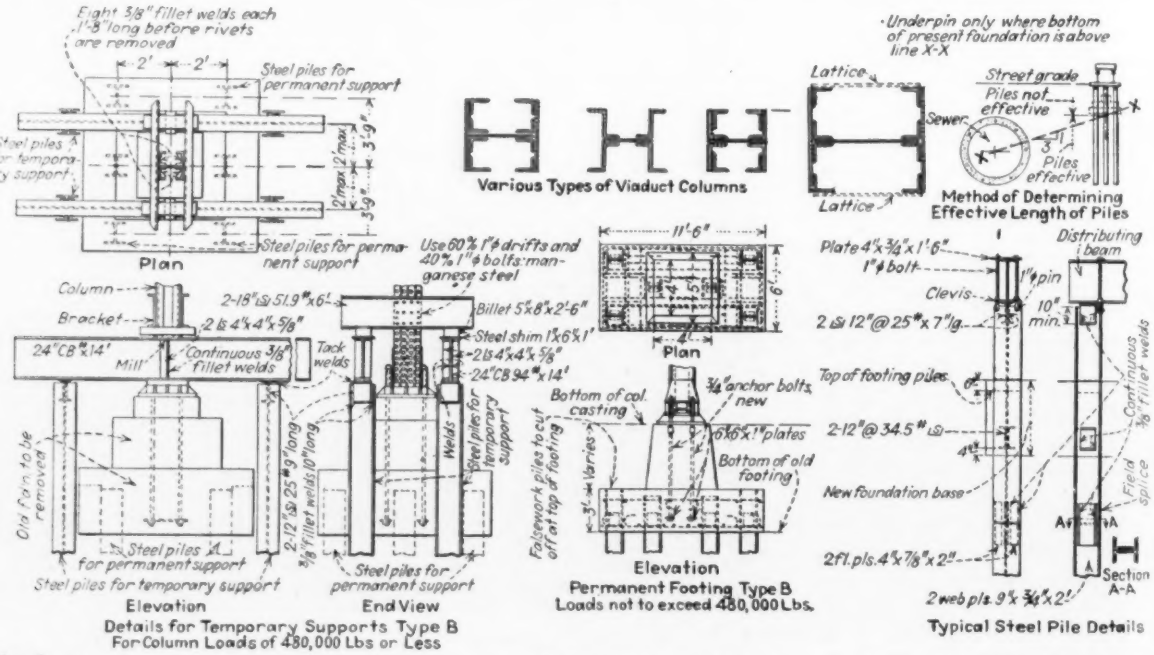

Fig. 3. Several types of pick-up assemblies are required because of varying column positions and loads. Here are two of the most common types, ready for driving of the new foundation piles.

section, from 3 ft. to 5½ ft. thick, topped by a trapezoidal pedestal carrying the column. New anchor bolts are set in the foundation; their tops are fastened to angles bolted to the bottom of the column just above the column base casting.

Pile driving

Most of the piles, both temporary support and foundation, are driven from the viaduct deck by a locomotive crane rig fitted with 60-ft. wooden leads. At times it is possible to take one of the outside tracks on the viaduct out of service for use of the piledriver, though frequently the rig has to be removed to clear trains. The pile sections are distributed along the ground line, and are snaked to position by a niggerhead line on the crane. As the leads do not extend below viaduct track level, it is necessary to use a long follower part of the time, consisting of a steel beam reinforced with timber.

Auxiliary drivers

In addition to the main driver on the viaduct, two auxiliary piledrivers operate at ground level. One of these, for use mainly on piles beyond the reach of the overhead rig, is an old steam crane unit carrying 75-ft. wooden leads. The other is a light crane, small enough to work under the viaduct, using short leads for the final driving of piles which are not finished by the main driving rig.

Test piles are driven at each bent location, and all foundation piles are driven to depths determined by the test units.

Direction

The pile driving and sewer work are part of the extensive interceptor sewer project being built by the department of public works of Detroit under the direction of L. G. Lenhardt, commissioner. L. V. Garrity is engineer in charge of construction of the project, and J. R. Hendry is resident engineer on Section 8. The W. J. Storen Company, Detroit, is doing the pile driving and underpinning under sub-contract with the Cooke Company. Frazier Snyder is superintendent for the contractor, with Robert Erwin and Harold Boyd as assistants.

University and City Cooperate In Furthering Sanitation Research

New laboratory at New York University provides special facilities for studying sanitary engineering

DEDICATION of the new sanitary engineering research laboratory at the college of engineering of New York University on Sept. 13, signalizes a major forward step in cooperative action between a municipality and a private educational institution. As the result of an agreement between the Department of Sanitation of New York City and New York University, this joint research center will provide unusual opportunities for studying sanitary problems of special interest to the city, provide for the training of selected municipal employees, and enable the college to carry on a broader program of educational service and research.

The research center comprises not only chemical and bacteriological laboratories with special preparation, research, and stock rooms, but also large tanks, pumps, filters, meters, etc., which provide for handling a sewage flow of 25,000 gal. per day through a rapid sand filter. Experiments may therefore be conducted upon a sufficiently large scale to reproduce actual conditions in practice.

The building is located on a plot of land formerly part of the campus at University Heights, but deeded to the city for the specific purpose for which it is to be used. Construction was undertaken under the auspices of the Department of Sanitation as a WPA project.

Terms of agreement

The principal objectives covered by the agreement between the city and the university include: (1) study of current problems in sewage treatment proposed by the Department of Sanitation; (2) use of the laboratory for studies relating to new sewage treatment plants and processes which may be projected or constructed by the city; (3) investigations of industrial wastes treatment; and (4) provision for several scholarships granted by the university to regular civil service employees of the Department of Sani-

Fig. 1. Devoted to sanitary engineering research, the laboratory building houses test equipment for plant scale operations.

tation; The laboratory is to be under the sole and exclusive supervision and control of New York University, thus assuring continuity and skilled direction of problems concerning sewage treatment, industrial waste treatment, garbage digestion, bathing beach and pool sanitation, and other public health subjects.

Building design and equipment

The building of steel, concrete and brick construction, is in the shape of an L with one side 85 ft. long and the other 65 ft.; the width is 28 ft. The architectural design is modernistic with 50 per cent of the wall space being windows. The tanks in the sewage laboratory, of reinforced concrete, are built with foundations separate from that of the building.

The chemical and bacteriological laboratory is 65 by 28 ft. with daylight on four sides. Four steel tables with acid resisting tops are provided fully equipped with gas, water and electricity. Two movable tables are provided in the center to give additional working space. There are two steel fume hoods with a built-in steam water bath equipped with a blower which provides 340 cu. ft. of air per min. The titration table is 6 ft. long under which are stored the reagents which are delivered to the burettes by compressed air.

The bacteriological room is provided with an autoclave, a 37 deg. and 20 deg. incubator, a stove, an electric refrigerator, and a water still with 30 gal. storage.

Connection with city sewer

Sewage is pumped by a centrifugal pump delivering 100 g.p.m. under a 50-ft. head from a nearby 3-ft. dia. combined sewer serving a residential district. The suction line of the pump goes into a pit located in a special manhole where part of the sewage flow can be diverted by an adjustable stop plank.

Sewage is pumped into a 4 x 4-ft. concrete tank in the building. The tank has an adjustable overflow so that a constant head can be maintained, and two lines of 4-in. steel pipe run from the tank to tanks in the laboratory. Arrangements have been made so that industrial wastes can be mixed with the sewage for test purposes.

Reinforced concrete tanks have been built to provide facilities for testing various types of equipment. The sizes and shapes of the tanks are: one, 5 x 5-ft.; one 8 x 8-ft.; one 12 x 12-ft.; one 10 x 20 ft.; and three 8 ft. circular. The 10 x 20-ft. tank has two inlets and outlets, so that by building a center baffle two similar tanks can be used for parallel studies on aeration and sedimentation. One of the 8 ft. circular tanks is 10 ft. deep and it can be used as a digestor. All of the tanks except the 10 x 20-ft. unit are mounted on columns so that samples can be collected from the bottom.

The sewage laboratory is 85 ft. long and 28 ft. wide. A removable checkered plate floor has been placed over a part of the room and catwalks lead to the various tanks. An overhead monorail with a 1-ton chain hoist provides for handling equipment and supplies. In the basement an acid chamber for the storage of acids in carboys is supplied.

Mechanical equipment which is being installed at the present time includes a centrifugal pump for raw sewage; an air blower delivering 50 cu. ft. of free air under 8 lb. pressure; a plunger sludge pump with a capacity up to 50 gal. per min. under a 30 ft. head, and a kitchen garbage grinder.

A 25,000 gal. per day rapid sand filter has been built so that any of the tanks in the laboratory can be used for coagulation basins and for studies on water purification. The filter is 3 ft. square and is so designed that the washwater trough and manifold are on the outside of the filter. It is constructed of welded steel plate with a 6-in. wire glass window in one side. Porous plates are used for the distribution of washwater.

The laboratory work will be under the direction of Thorndike Saville, dean of the College of Engineering, assisted by Lewis V. Carpenter, professor of sanitary engineering.

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Earth Shocks at Boulder Dam

Recently published data on Boulder Dam earthquakes (*ENR*, July 29, 1937, p. 178) have been supplemented by additional reports. The revised record shows a total of thirteen shocks in the month of June, including two of intensity II, eight of intensity III, two of intensity IV, and one of intensity V, modified Mercalli scale. It should be noted that the instruments are owned and operated by the U. S. Bureau of Reclamation; the U. S. Coast and Geodetic Survey has supervised installation of the equipment and functions as consultant to the bureau in interpretation of seismic records obtained.

In some quarters the reported earthquake activity has led to the inference that there might be important displacements in the vicinity of the dam. Capt. J. H. Hawley, acting director of the Coast and Geodetic Survey, states that earthquakes which do not exceed intensity V are not accompanied by earth movements that can be measured. The misapprehension seemed to have arisen through press reports of scientific discussion based on a paper presented by a member of the Survey at the meeting of the Eastern Section of the Seismological Society of America at St. Louis, Mo. on June 10, 1937, which contained nothing of significance in regard to the safety of the dam from earthquakes but was purely a discussion as to how the earthquakes might be more accurately located under the very difficult conditions imposed by the sparsely populated character of the region.

Correspondence from Boulder City, Nev., brings out some additional information: Comparison of lake level fluctuations with the record of shocks does not indicate that a stationary lake level means an absence of earthquakes. It is regarded simply as coincidence that during the month of July, when no earthquake shocks were recorded, Lake Mead rose 6 ft. and for the last week of that month was virtually at the same level.

A naturalist of the National Park Service, speaking in Boulder City not long ago, mentioned indications that a natural lake existed on the site of Lake Mead in comparatively recent geological times. This suggested the thought that the area may now be readjusting itself to a condition of loading that obtained previously.

THE WEEK'S EVENTS

Continued from page 455

Texas Intercoastal Canal To Be Completed

Construction of the uncompleted section of the intercoastal canal between Galveston and Corpus Christi is now assured, according to Roy Miller, vice-president of the Intercoastal Canal Association. Mr. Miller has announced that bids will be asked soon for dredging a 12-mile stretch of the inland waterway, extending east from the Galveston county line to Shreveport. When the Galveston-Corpus Christi division of the canal has been finished, the final section between Corpus-Christi and the mouth of the Rio Grande, about 120 miles, will be put under way, Mr. Miller said. The section of the canal between the Mississippi and Galveston is already in use by barges.

For the past several years, construction work on the canal south of Galveston has been delayed by right-of-way and bridge problems. The act authorizing construction of the canal placed the obligation of building, operating and maintaining highway bridges over the canal and of furnishing right-of-way upon local interests. Some counties along the route were financially unable to meet the obligation, and after efforts to solve the problem in other ways the state highway commission has agreed to build and operate the bridges at the expense of the state.

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Borers In L. I. Sound

The presence of teredo navalis, a marine worm, was revealed in devastating numbers by a survey of the Connecticut Shore in Long Island Sound, completed recently by Duxbury, Mass., Federal laboratory engineers.

The teredo navalis is a boring worm that attacks wooden piling, honeycombing it and finally causing it to break and fall away, if it is holding up weight.

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Bahama Building Boom Attracts U. S. Labor

Strict immigration laws have been relaxed in the Bahama Islands because of the building boom, permitting a limited number of skilled workmen to be taken there from the United States. The minimum wage for unskilled labor is $1 a day, this being a 25-cent increase over the former scale, with the skilled workers averaging $5 to $7.50 a day. Hilltop and waterfront sites, decayed and not used since the emancipation of the slaves in 1834 are being restored into palatial homes.

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Soil Study Course Offered By Roads Bureau

A course in the surveying, sampling and testing of soil and in the practical application of the results of soil tests to highway design, construction and maintenance, is to be offered to Highway Engineers, October 4-16, by Research Engineers of the Bureau of Public Roads.

Instruction will be furnished by members of the Bureau of Public Roads and opportunity will be afforded those attending to perform the tests and to preserve data. The Bureau asks that highway engineers interested in taking the course make prompt application for enrollment, giving data as to position and previous experience.

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Rats Are First Problem On Jefferson Memorial

J. B. Rasbach, technical assistant on the Jefferson Memorial at St. Louis, states that the problem of exterminating rats in the 37-block area comprising the proposed memorial will engage the attention of his department before demolition of buildings is begun. He stated that advice and cooperation of the Department of Agriculture will be sought this winter with the expectation that the area will be comparatively free of rats when razing operations start, probably in the spring.

It is essential, he said, that the rats be exterminated before the old buildings are torn down or they will move to other buildings.

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Panama Wants Tunnel

A transportation tunnel under the Panama Canal costing an estimated $2,000,000, has been requested by Panama to provide better facilities between the two parts of the Central American republic. A small ferry with facilities for 22 cars is the only connecting link now.

Traffic Records are Set On Tunnel and Bridge

New traffic records for one-month and eight-month periods were established in August through the Holland Tunnel and the George Washington Bridge, the Port of New York Authority has announced. In August, 1,240,000 vehicles passed through the Holland Tunnel, upsetting a record set in August, 1931, when the count was 1,225,000. For the eight months ending August 31, the Holland Tunnel handled 8,585,000 vehicles as compared with 8,408,000 for the first eight months of 1931; a gain of 13 per cent was registered over the first eight months of 1936.

Traffic in August on the George Washington Bridge totaled 950,000, five per cent heavier than August 1936, which was the previous record traffic. For the first eight months of this year, the George Washington Bridge was used by 5,350,000 cars, 15 per cent greater than for the first eight months of last year.

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Quebec and C.P.R. Study Abitibi Line

Means of linking the rich Abitibi region with the principal centers of the province of Quebec by railway are being investigated by Quebec Government Authorities and representatives of the Canadian Pacific Railway Company. The cost of the study will be divided equally between the two agencies.

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German Shortage

All buildings in Germany must be built of stone or concrete except in cases of extreme necessity, according to an order recently issued by the German building department. Iron and steel are not to be used for building materials, and wood is only to be used in roofs. The order arises from the acute shortage of iron, steel and wood now existing in Germany.

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Concrete Ceilings Opposed By N. Y. Plasterers

Construction of two new school buildings in New York City has been held up by refusal of union plasterers to work under specifications calling for concrete rather than plaster ceilings in the class rooms. The union refused to do plastering work on the buildings.

The concrete ceiling specification was introduced by the City Board of Education because of possible danger from falling plaster.

CALENDAR OF MEETINGS

NATIONAL SOCIETIES

AMERICAN SHORE AND BEACH PRESERVATION ASSOCIATION, mid-year conference, Chicago, Sept. 27-28.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Boston, Sept. 27-30.

AMERICAN PUBLIC WORKS ASSOCIATION, annual conference, Atlanta, October 4-6.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, New York, Oct. 5-8.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting, Boston, Oct. 6-8.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, annual meeting, Scranton, Pa., Oct. 11-13.

NATIONAL SAFETY CONGRESS, Kansas City, Oct. 11-15.

AMERICAN WELDING SOCIETY, annual meeting and exposition, Atlantic City, N. J., Oct. 18-22.

CANADIAN INSTITUTE OF SEWAGE AND SANITATION, annual convention, London, Ont., Oct. 21-22.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual convention, White Sulphur Springs, W. Va., Oct. 27-29.

REGIONAL AND LOCAL

SECTION MEETINGS, AMERICAN WATER WORKS ASSOCIATION: Rocky Mountain, Santa Fe, N. M., Sept. 20-22; New York, Schenectady, Sept. 30-Oct. 1; Minnesota, St. Paul, Oct. 7-9; New Jersey, Atlantic City, Oct. 15-16; Southwest, Austin, Tex., Oct. 18-21; California, Sacramento, Oct. 20-23; Virginia, Richmond, Nov. 4-6; Missouri Valley, Omaha, Nebr., Nov. 4-6; Wisconsin, Green Bay, Nov. 8-10.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, Poland Spring, Me., September 21-24.

ROCKY MOUNTAIN SEWAGE WORKS ASSOCIATION, first annual meeting, Santa Fe, N. M., Sept 20-23.

SOUTH DAKOTA WATER AND SEWAGE WORKS CONFERENCE, annual meeting, Sioux Falls, S. D., Oct. 11-12.

TEXAS PUBLIC HEALTH ASSOCIATION, annual meeting, Dallas, Nov. 1-3.

ELECTIONS AND ACTIVITIES

THE FOLLOWING OFFICERS were elected at the annual convention last month of the North Carolina Section of the American Water Works Association, held jointly with the North Carolina Sewage Works Association: J. W. Kellogg, president; R. A. Thomas, vice-president; A. R. HOLLETT, secretary-treasurer.

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License Examination

IOWA: Examinations for professional engineering, Sept. 21-22 and for land surveying, Sept. 23, in the Senate Chamber at the State House, Des Moines, Iowa.

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U. S. Meteorologists Go To Salzburg

At the international meteorological meetings in Salzburg, Austria, this month, the U. S. Weather Bureau will be represented by its chief, Dr. W. R. Gregg, and Ivan R. Tannehill, chief of the Marine Division. Doctor Gregg is president of a newly organized commission known as the Commission on Projections for Meteorological Maps. Because of his special study of the important questions of projections and scales for use by meteorological services, Mr. Tannehill will take an active part in the discussions at the meetings of this commission. The meetings are expected to do much toward standardizing this phase of meteorological service throughout the world.

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Public Works Congress Will Meet in Atlanta

Typical problems in operation and administration will replace emergency, "made-work" problems as subjects for discussion at the 1937 Public Works Congress in Atlanta, October 4-6.

A symposium on needed research in street paving practice will include as participants: H. F. Clemmer, engineer of materials, Washington, D. C., on concrete; J. T. Pauls, senior highway engineer, U. S. Bureau of Public Roads, on bituminous materials; and Roy Phillips, city engineer, Meadville, Pa., on brick. There will also be two panel discussions, one on refuse collection and the other on personnel problems.

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Survey for Washington Dam

Work by U. S. Army Engineers will start shortly on a survey of the site of a proposed flood control dam on the Puyallup river in Washington. The proposed dam as recommended would consist of a concrete arch to be built about five miles east of Buckley, in a deep rock canyon.

Two Hydro Projects Proposed in Idaho

Applications have been made to the Idaho state reclamation commission for two large power and reclamation projects, both on the Snake River near Bliss.

Governor Barzilla W. Clark filed an application for a permit to establish a hydro-electric power plant on what is known as the Ticesha site on the Snake River, 8 miles west of Bliss. He stated that it is possible to develop 100,000 hp. on this site at a cost of $2,500,000. Power from the dam would be used for the manufacture of fertilizer from phosphate beds in southeastern Idaho and for further development of irrigation in Owyhee and Canyon counties.

Ray J. Lyman, chief engineer for the Twin Falls Extension Co. of Twin Falls, Idaho, filed an application to build a $12,000,000 dam for storage of waters in Snake River Canyon 1½ miles south of Bliss. The dam would store 1,250,000 acre-ft. of water annually for power generation and the reclamation of 675,000 acres of arid land in southwestern Idaho. The dam would be an earth fill with concrete core 470 ft. high and 4,100 ft. long.

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CCC Enrollment Drops As Men Get Jobs

Civilian Conservation Corps enrollees have been obtaining private employment this summer at a faster rate than during any previous time since the corps was established in 1933. During July, the total of 13,856 enrollees were discharged to accept jobs offered to them. This is an increase of about 300 men over figures for June, of 2,000 men over May, and of about 6,000 over April.

The terrific acceleration in employment rate is attributed partly to improved employment conditions and also to the efforts being made by CCC camp officials and other agencies to find employment for the thousands of CCC men who will not be eligible to re-enroll in the corps when a new replacement enrollment program is begun October 1. About 89,545 men will be prevented, either by the new requirement that no one may serve more than two years in the corps or by another new requirement setting age limits of 17 to 23 for enrollees, from re-enrolling in October.

By the end of the month, the enrolled strength of the CCC will drop to below 200,000 men. Arrangements are now being made to construct a replacement enrollment program in October to fill vacancies.

OBITUARY

GEORGE W. READY, a retired Florida contractor, builder of hotels there, died in Brooksville, Fla., Aug. 18.

FRED B. WARD, 41, an inspector of the Arkansas state highway department, died Aug. 18 in Conway, Ark.

HAROLD F. GALLIVAN, president of the Gallivan Construction Co. of Greensville, S. C., died Aug. 18 in Greensboro, N. C.

JOHN C. DAVIDSON, a civil engineer in the service of Norfolk County, Mass., died in Gardner, Mass., July 27 at the age of 46 after an automobile accident.

BERNARD O. WOOD, 70, who retired last month after a 40 year connection with the engineering department of the Mobile & Ohio Railroad, of which he had been chief engineer since 1910, died in Tuscaloosa, Ala., Aug. 19.

WILLIAM H. STEVENS, Philadelphia consulting engineer and at one time connected with the Pennsylvania Railroad, died on shipboard en route to Cuba Sept. 1 at the age of 47. Mr. Stevens studied at Cornell University and served in France during the war.

HORACE E. OSGOOD, general manager and treasurer of the Osgood Construction Co. of Nashua, N. H., died in that city on Aug. 31 at the age of 61. He had been in construction work in New Hampshire since 1901 and became manager of the concern bearing his name in 1924.

JEREMIAH J. MCDONALD, an engineer who practiced in Canada and England, died in London Sept. 4. Mr. McDonald was a graduate of McGill University and was at one time chief engineer of the Halifax Harbor Commission and later was associated in consulting work with Sir Alexander Gibb of England.

NEWBOLD DRAYTON, civil engineer and graduate in 1908 of the University of Pennsylvania, who had been engaged on railroad construction work in this country, Chile, and China, and who had recently been connected with the Indemnity Insurance Company of North America, died Sept. 4 in Philadelphia at the age of 54.

SAM W. CALDWELL, Sr., 53, a construction superintendent with the Alabama highway department, died in Birmingham Aug. 18 from gunshot wounds said to have been self-inflicted. Mr. Caldwell was connected with the Tennessee Coal, Iron & Railroad Co. in the engineering department for several years and was a graduate of Alabama Polytechnic Institute.

E. N. LUCE, county engineer of Ashtabula county, Ohio, died in Ashtabula Sept. 2 at the age of 48. Mr. Luce had been a county employee since 1914 and had been county engineer since 1932. For 14 years he was county maintenance engineer and state highway maintenance superintendent. He served two terms as president of the Northeast Ohio Society of Professional Engineers.

THOMAS C. B. SNELL, who retired in 1925 after many years service with the National Board of Fire Underwriters and the New York Fire Insurance Exchange, died Sept. 2 in Newark, N. J. at the age of 66. Mr. Snell was a graduate of the Sheffield Scientific School of Yale University and of Cornell University and before he became structural and electrical engineer for the commission on fire prevention of the National Board of Fire Underwriters in 1907, he had done much work on the civil engineering phases of electric street railway construction as well as some structural work, practicing mostly in Hartford.

JOHN W. BURKE, New York engineer connected with the J. G. White Engineering Corp. and a specialist in utility and industrial property appraisals, died in Manchester, Vt. Sept. 2, aged 72. Mr. Burke was a graduate in 1887 of Worcester Polytechnic Institute and after several years connection with the Boston & Albany and the Rutland R.R., he practiced in Rutland, Vt., as a member of the firm of Chappell & Burke. In 1889 he began to practice in New York City, staying there for several years, and then returned to railroad work with the Rutland-Canadian R.R. and the Sherbrooke Electric Ry. Since 1909 he has been connected for the greater part of the time with the J. G. White Corp.

RUSSELL L. HUNTLEY, who retired in 1927 as chief engineer of the Union Pacific Railroad System, died recently in Los Angeles. At the time of his retirement, Mr. Huntley had been chief engineer for nine years and had been in the service of the Union Pacific for 39 years. After his graduation in 1880 from Rensselaer Polytechnic Institute, he entered the engineering department of the New York Central and Hudson River R.R. Six years later he became location engineer for the St. Joseph and Grand Island Ry., and in 1888 he entered the service of the Union Pacific as an assistant engineer. He became principal assistant engineer a year later in charge of location and construction work and in 1906 he became chief engineer of the Union Pacific R.R. In 1918 he was promoted to chief engineer of the Union Pacific System.

PERSONAL

HAROLD J. MONK has been appointed city engineer of Iowa City.

CHARLES T. G. LOONEY has been appointed assistant professor of civil engineering at the University of Iowa.

ZINA E. SEVISON, city engineer of Cheyenne, has resigned to become state highway engineer of North Dakota.

GLENN MATTESON, chief engineer of the Aberdeen, S. D., district of the WPA, has become state hydraulic engineer for that agency.

HENRI RUSH, St. Louis architect and former chief engineer of that city, has taken a position in Russia to participate in the building program there.

ELMER ORTMAYER, area engineer for WPA in Marshall, Day, and Brown counties, S. D., has been appointed district engineer for the Aberdeen district.

THOMAS REESE has been appointed assistant city engineer of East St. Louis, Ill., to replace J. F. Kilpatrick, who resigned recently.

LOREN R. BLAKELEY, assistant engineer of the Pasadena, Calif., water department, has resigned to become an engineer for the Santa Ana Valley Irrigation Co. at Orange, Calif.

EUGENE H. IMLER, assistant engineer of the Pasadena, Calif. water department, has resigned to take a position with the Imperial Valley Irrigation District.

F. B. WIEGAND, signal engineer of the New York Central System, has been granted an extended jurisdiction which now includes the Cleveland, Cincinnati, Chicago and St. Louis Ry. His headquarters remain at Cleveland.

THOMAS R. WHITE, who has been chief administrative assistant in the Memphis district of the U. S. Engineers, has become chief administrative assistant in the Southwestern Division office at Little Rock.

R. E. HILES, who has been associated with the inspection division of PWA in Arkansas and with the bridge department of the Arkansas state highway commission, is now connected with the Ingalls Iron Works Co. at Birmingham, Ala.

ROSS WHITE, general superintendent of construction of the Tennessee Valley Authority, Knoxville, has resigned to become general manager of the Brown Root, Inc.-McKenzie Construction Co., builders of Marshall Ford dam. Mr. White took up his new duties Sept. 1.

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

IRRIGATION CANALS, MONTANA

OWNER: Bureau of Reclamation, Dept. Interior; R. F. Walker, Chief Engineer.

PROJECT: Construction of earthwork and structures for Sun River Slope laterals near Fairfield and Augusta, Mont., including installation of 2,200 lin.ft. 15 to 30 in. concrete and metal flume, gates and misc. metal work.

BIDS: Nine bids were submitted July, 1937, ranging from the low of $65,774 to a high of $98,881; completion scheduled for 400 days after contract award. Minimum hourly wages stipulated at $1.20 for skilled and 50c for common labor.

CONDITIONS: Govt. furnishes all material f.o.b. Fairfield, exclusive of concrete aggregates, sand for grout, backfill and gouted paving, form materials, and in general all materials not entering into the finish construction.

LOW BIDDERS:

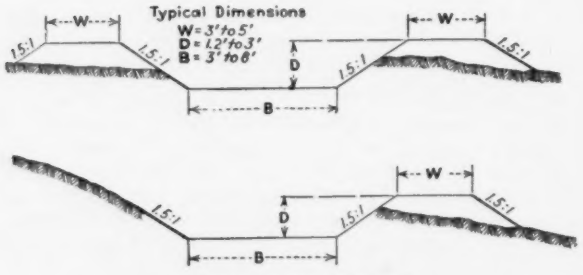
1. Otis Williams & Co., Vale, Ore..... $65,774
2. E. C. Powell, Missoula, Mont..... 70,828
3. Dan Teters & Co., Ogden, Utah..... 75,072

SCHEDULE I

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Excav. laterals, unclass ..	42,000 c. y.	$0.16	$0.19	$0.18
2. Overhaul	5,300 c. y.	.04	.05	.04
3. Excav. struct. unclass ...	3,300 c. y.	1.00	1.00	1.25
4. Backfill, structures	3,150 c. y.	.25	.21	.30
5. Structure puddling	1,100 c. y.	.30	.20	.50
6. Concrete	730 c. y.	20.00	22.00	20.00
7. Place reinf. bars	52,000 lb.	.03	.02	.03
8. Grouted paving	550 s. y.	2.00	2.50	2.00
9. Dry dock paving	180 s. y.	1.00	1.00	1.50
10. Erect struct. timber	3 m. b. m.	16.00	40.00	40.00
11. Lay conc. pipe, 15 in	328 l. f.	.50	.50	1.00
12. Lay conc. pipe, 18 in	320 l. f.	.60	.50	1.50
13. Lay conc. pipe, 24 in	80 l. f.	1.00	.50	2.00
14. Lay conc. pipe, 30 in	8 l. f.	1.50	.50	3.00
15. Lay c. m. pipe, 15 in	50 l. f.	.20	.50	.35
16. Lay c. m. pipe, 21 in	220 l. f.	.40	.50	.50
17. Lay c. m. pipe, 30 in	20 l. f.	.50	.50	.75
18. Instal gates, misc. metal..	13,700 lb.	.05	.04	.04

SCHEDULE II

19. Excav. laterals, unclass...	27,000 c. y.	.16	.19	.18
20. Overhaul	2,200 c. y.	.04	.05	.04
21. Excav. struc. unclass	2,300 c. y.	1.00	1.00	1.25
22. Backfill, structs	2,300 c. y.	.25	.21	.30
23. Struct. puddling	700 c. y.	.30	.30	.50
24. Concrete	450 c. y.	20.00	22.00	20.00
25. Place reinf. bars	31,000 lb.	.03	.02	.03
26. Grouted paving	350 s. y.	2.00	2.50	2.00
27. Dry dock paving	100 s. y.	1.00	1.00	1.50
28. Erect struct. timber	2 m. b. m.	16.00	40.00	40.00
29. Lay conc. pipe, 15 in	128 l. f.	.50	.50	1.00
30. Lay conc. pipe, 18 in	284 l. f.	.60	.50	1.50
31. Lay conc. pipe, 24 in	8 l. f.	1.00	.50	2.00
32. Lay conc. pipe, 40 in	40 l. f.	1.50	.50	2.50
33. Lay c. m. pipe, 15 in	20 l. f.	.20	.50	.55
34. Lay c. m. pipe, 21 in	150 l. f.	.40	.50	.50
35. Lay c. m. pipe, 30 in	70 l. f.	.50	.50	.75
36. Instal gates, misc. metal..	10,000 lb.	.05	.04	.04



TYPICAL CANAL SECTIONS

SCHEDULE 3

37. Excav. lateral, unclass....	23,000 c. y.	.16	.19	.18
38. Overhaul	1,700 c. y.	.04	.05	.04
39. Excav. struct. unclass....	1,600 c. y.	1.00	1.00	1.25
40. Backfill, structs	1,750 c. y.	.25	.21	.30
41. Struct. puddling	600 c. y.	.30	.30	.50
42. Concrete	410 c. y.	20.00	22.00	20.00
43. Place reinf. bars	27,700 lb.	.03	.02	.03
44. Grouted paving	320 s. y.	2.00	2.50	2.00
45. Dry rock paving	70 s. y.	1.00	1.00	1.50
46. Erect struct. timber	4 m. b. m.	16.00	40.00	40.00
47. Erect metal flume, No. 72.	93 l. f.	1.00	1.00	1.50
48. Lay conc. pipe, 15 in	140 l. f.	.50	.50	1.00
49. Lay conc. pipe, 18 in	124 l. f.	.60	.50	1.50
50. Lay conc. pipe, 24 in	100 l. f.	1.00	.50	2.00
51. Lay conc. pipe, 30 in	16 l. f.	1.50	.50	3.00
52. Lay c. m. pipe, 15 in	50 l. f.	.20	.50	.35
53. Lay c. m. pipe, 21 in	80 l. f.	.40	.50	.50
54. Lay c. m. pipe, 30 in	30 l. f.	.50	.50	.75
55. Instal. gates, misc. metal .	7,000 lb.	.05	.04	.04

MISSOURI RIVER REVETMENT

OWNER: U. S. Engineer Department, Kansas City District.

PROJECT: Construction of 1,191 lin. ft. of standard woven lumber mattress revetment, pile anchored, and 100 lin. ft. of pile revetment on the Missouri River near New Haven, between Mile 77 and Mile 82. Lumber mattress is to be weighted with stone.

CONDITIONS: Contract time 60 days. Minimum wage rates are $1.10 for skilled, 65c. for semi-skilled and 45c. for common labor. Transportation available by rail, water and highway. Piles and timber will probably come by water; stone by rail or water, depending upon quarry location.

BIDS: Opened Aug. 5, 1937. Bids were requested under two proposals: (1) government furnishing of all lumber and piling only, f.o.b. Gasconade, Mo. (Mile 103), contractor to haul to site in own barges; (2) contractor supplying all materials. The government values the piles and lumber at $5,103, and used this figure in determining the low proposal. Four contractors submitted bids, though only one bid of both proposals. Total of all bids and all unit prices shown below. Government estimate $24,336.

ALL BIDDERS:

Government furnishing of piles and lumber:

1. W. D. Glasscock, Kansas City, Mo. (contract) $19,307*
2. R. Newton McDowell, Inc., Kansas City, Mo. 20,754*
3. Woods Bros. Const. Co., Lincoln, Nebr.... 22,021*

* Exclusive of $5,103 government material cost.

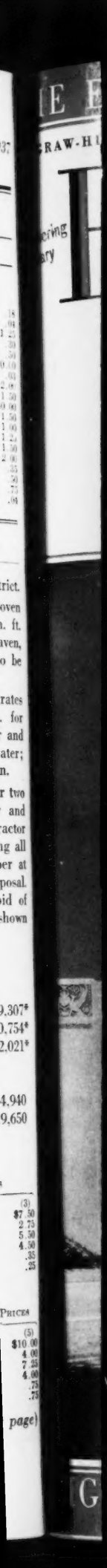
Contractor furnishing all materials:

4. W. D. Glasscock, Kansas City, Mo..... $24,940
5. The Massman Const. Co., Kansas City, Mo. 29,650

GOVERNMENT LUMBER AND PILING

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Lumber mattress	1,100 sq.	$5.00	$5.50	$7.50
2. Stone on mattress	1,420 ton	3.30	3.10	2.75
3. Stone in hand-placed paving..	1,050 ton	4.90	5.25	5.50
4. Spalls in paving	675 ton	4.30	4.75	4.50
5. Anchor piles	1,260 l. f.	.30	.53	.35
6. Piles and stringers	2,150 l. f.	.30	.40	.25

CONTRACTOR'S PILING AND LUMBER

Item	Quan.	Unit Prices (4)	(5)
1. Lumber mattress	1,100 sq.	$9.00	$10.00
2. Stone on mattress	1,420 ton	3.30	4.00
3. Stone in hand-placed paving	1,050 ton	4.90	7.25
4. Spalls in paving	675 ton	4.30	4.00
5. Anchor piles	1,260 l. f.	.65	.75
6. Piles and stringers	2,150 l. f.	.65	.75

(Additional Contract Unit Prices on second following page)